North Carolina Energy Code
Future of Commercial Requirements

2008 North Carolina Energy Star Conference

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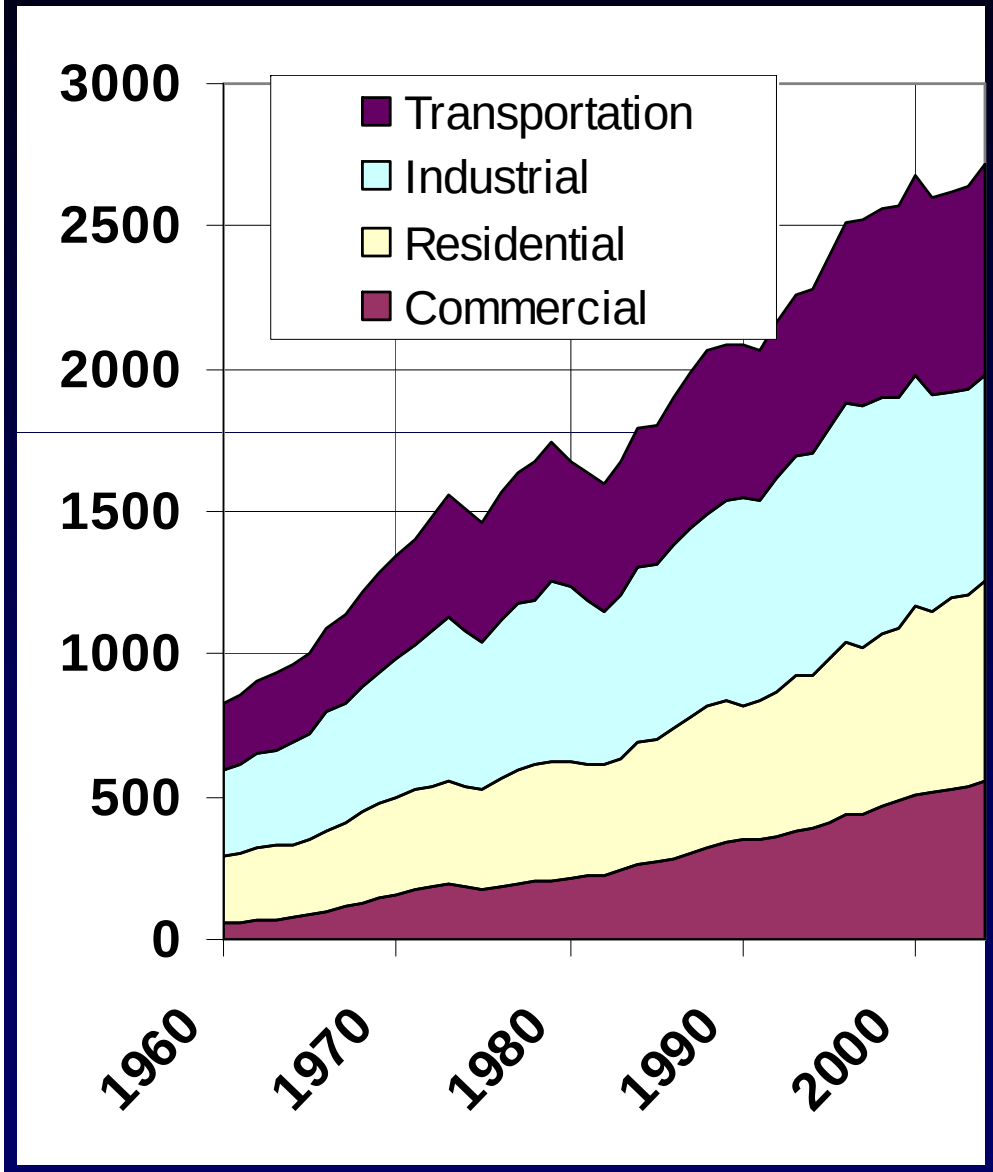
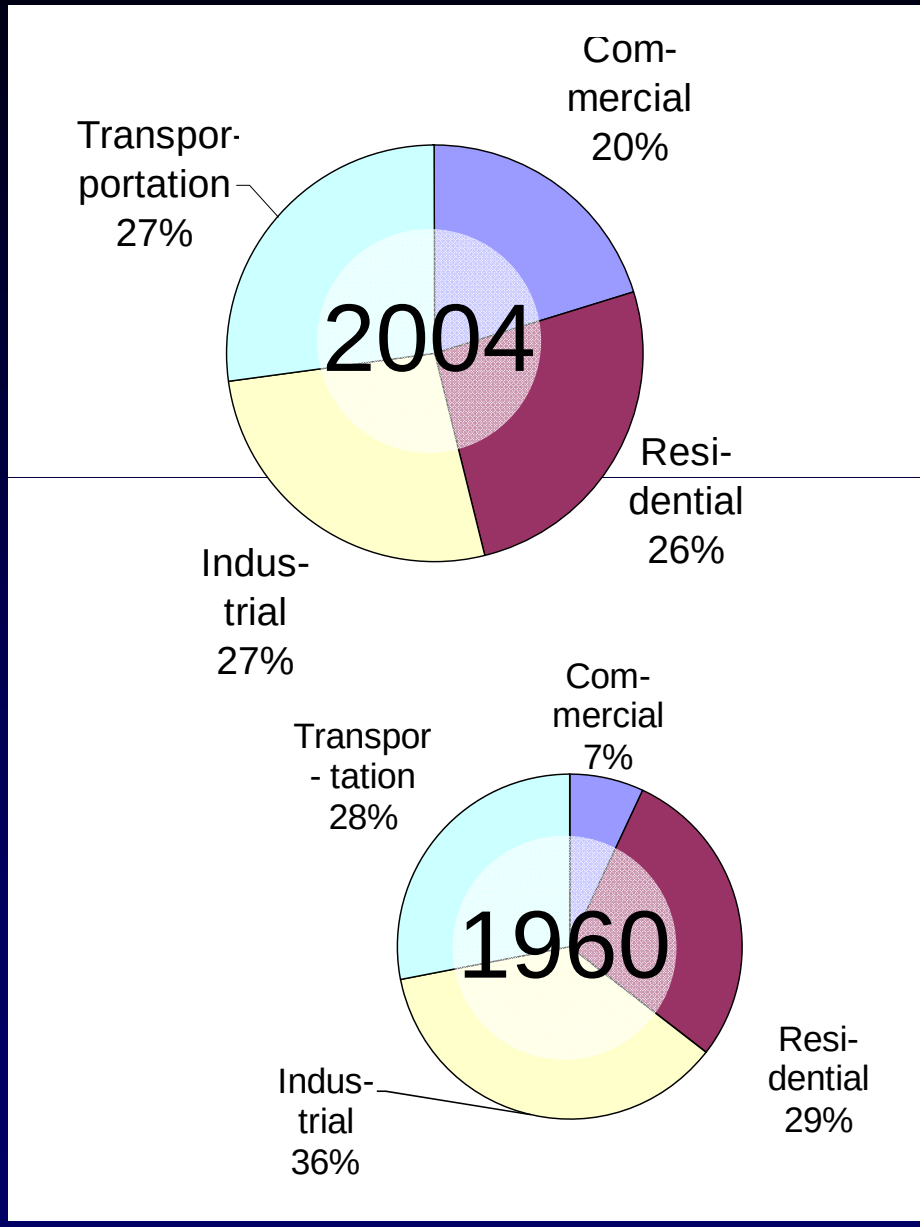
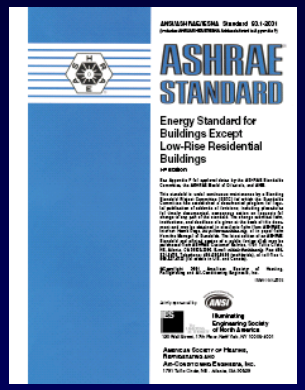
Total Energy Use by Sector (TBtu)



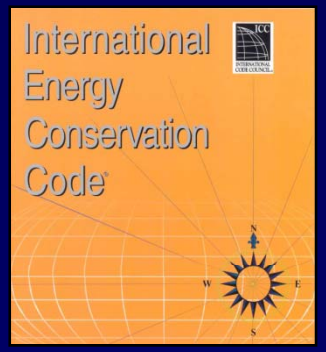


Two Sets of Requirements – multiple pathways to compliance



Building Design for All Commercial Buildings

– *Chapter 7 -- ASHRAE 90.1-2004 in the North Carolina energy code*



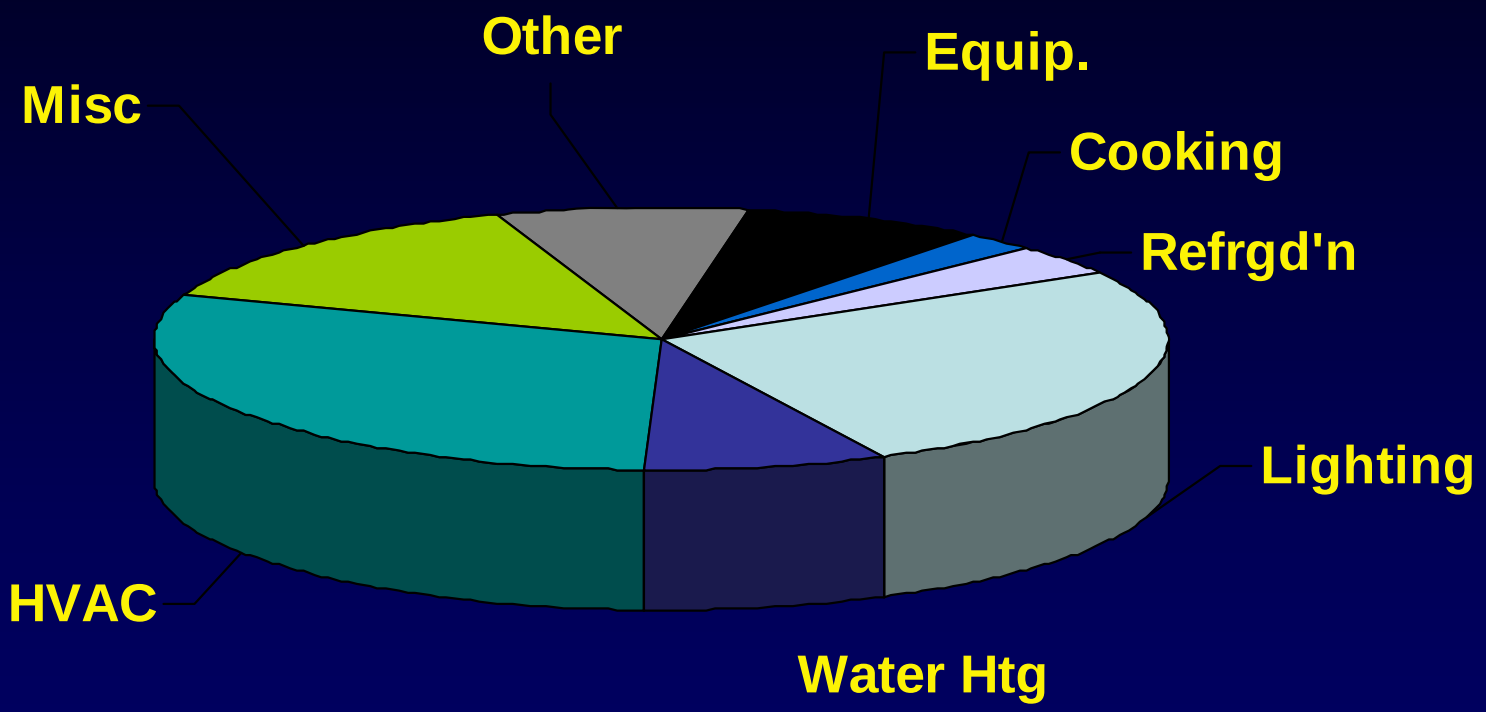
Design by Acceptable Practice for Commercial Buildings

– *Chapter 8 – part of the IECC 2004 – with local amendments*

Energy Consumption in Commercial Buildings

- More than half of energy use is for HVAC and lighting
- Energy bill equals 25% of total operating costs
- Climate sensitive design and off-the-shelf technologies can cut energy bill by 50%

Typical Commercial Building Energy Consumption Patterns



Chapter 7 → ASHRAE 90.1

The BIG chapter…

www.ASHRAE.org

CHAPTER 7

BUILDING DESIGN FOR ALL COMMERCIAL BUILDINGS

SECTION 701
GENERAL

701.1 Scope. Commercial buildings shall meet the requirements of ASHRAE/IESNA 90.1.

Exception: Commercial buildings that comply with Chapter 8.

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Exception: Commercial buildings that comply with Chapter 8.

Referenced Standards

ASHRAE

90.1—2004 Energy Standard for Buildings Except Low-Rise Residential Buildings

Organization of ASHRAE Standard 90.1-2004

1 Purpose

2 Scope

3 Definitions

4 Administration and Enforcement

5 Building Envelope

6 Heating, Ventilating, and Air-Conditioning

7 Service Water Heating

8 Power

9 Lighting

10 Other Equipment

11 Energy Cost Budget Method

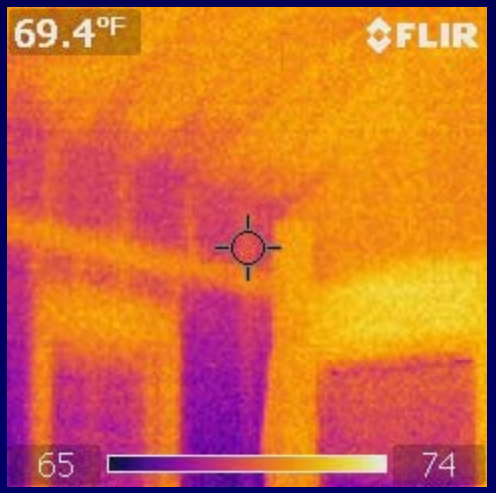
12 Normative References

High Rise Residential – Which Energy Code?

Key Concepts

Section 5 – Envelope

- Building envelope does not use energy
- Design affects heating and cooling loads
- Insulation affects the temperature of inside surfaces; comfort
- Daylighting can reduce electric lighting

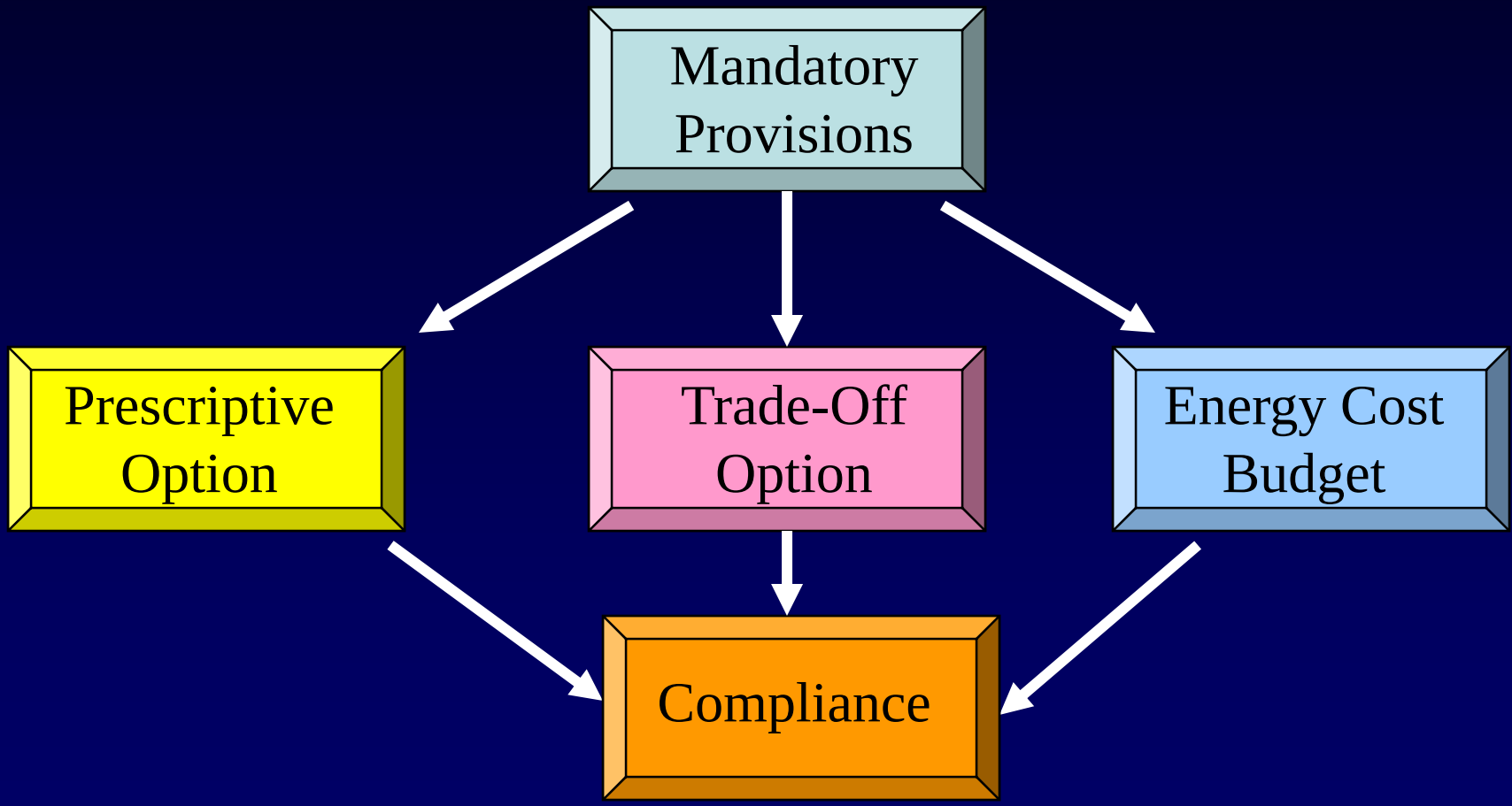


Section 5 – Envelope, cont'd

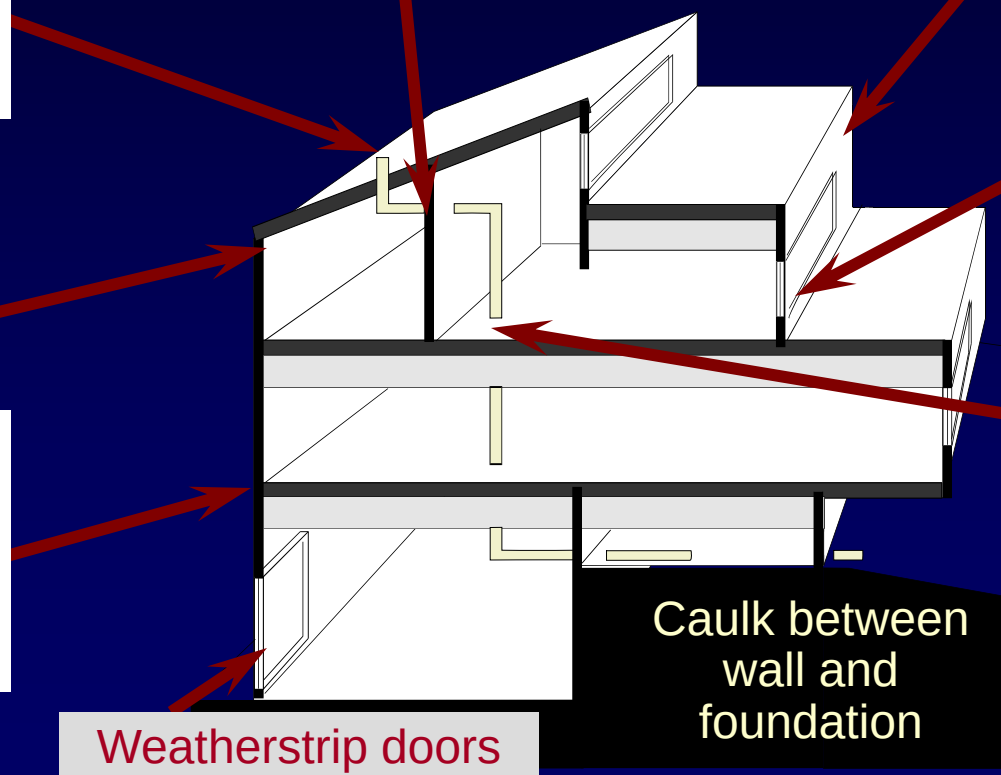
- Integrated design approach saves energy
- Building envelope requirements address:
  - *Opaque elements*
    - Roofs, walls, floors, below-grade walls, slabs, opaque doors
  - *Fenestration*
    - Windows, doors, skylights
- How often do we get the chance to get this part of the building right?

Section 5
Envelope Compliance Methods

Section 5.2



502.3 Basic Requirement: Air Leakage - Building Envelope Sealing



Caulk around penetrations of chimney flue vents or attic hatches

Caulk between wall panels particularly at corners and changes in orientation

Caulk around doors and windows

Caulk between wall arch floor where floor penetrates wall

Caulk between wall and roof

Caulk at penetrations of utility services or other service entry through walls floors and roofs

Caulk between wall panels and top and bottom plates in exterior walls

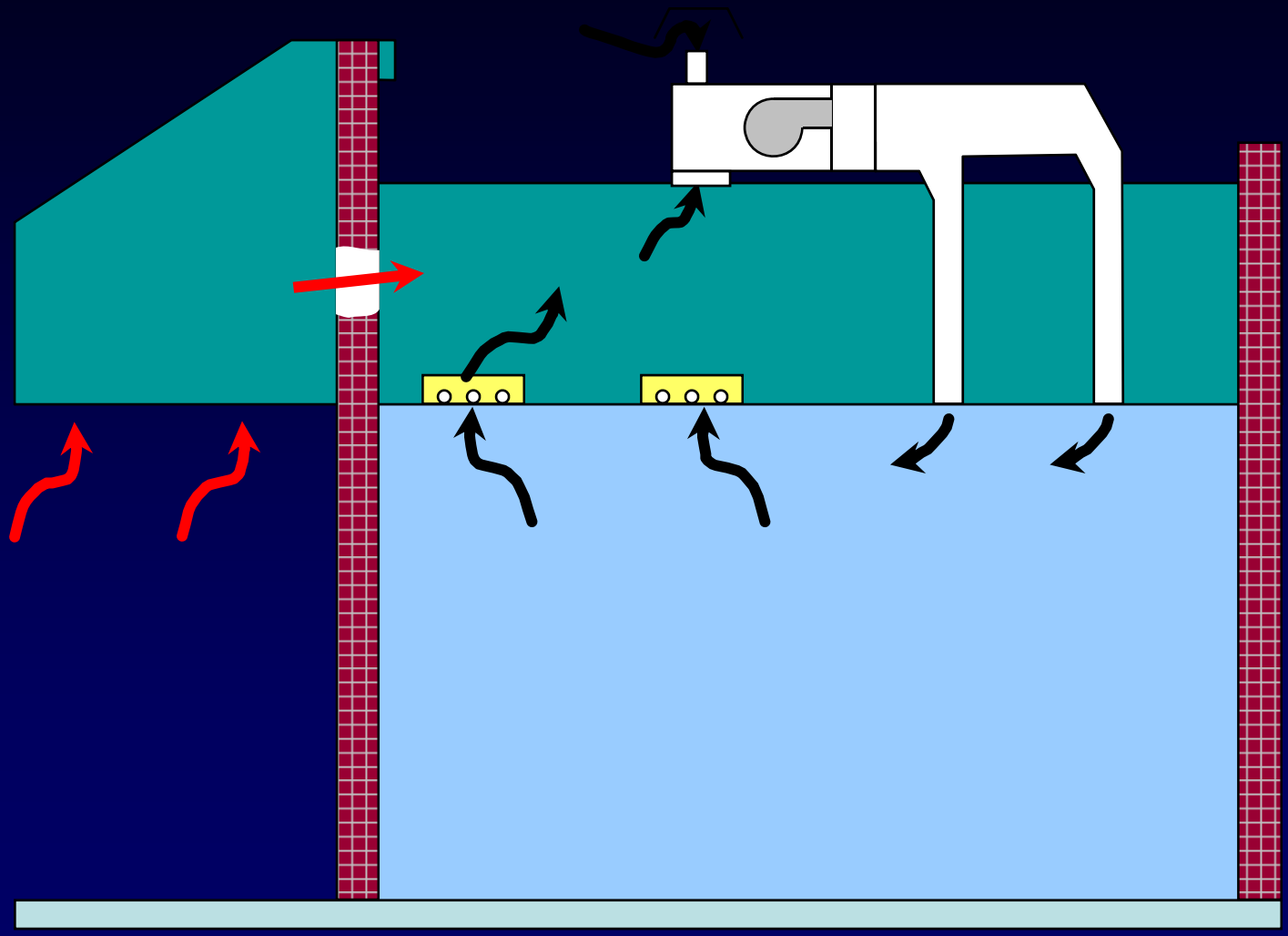
Caulk between wall and foundation

Weatherstrip doors

Major Air Leakage Sites

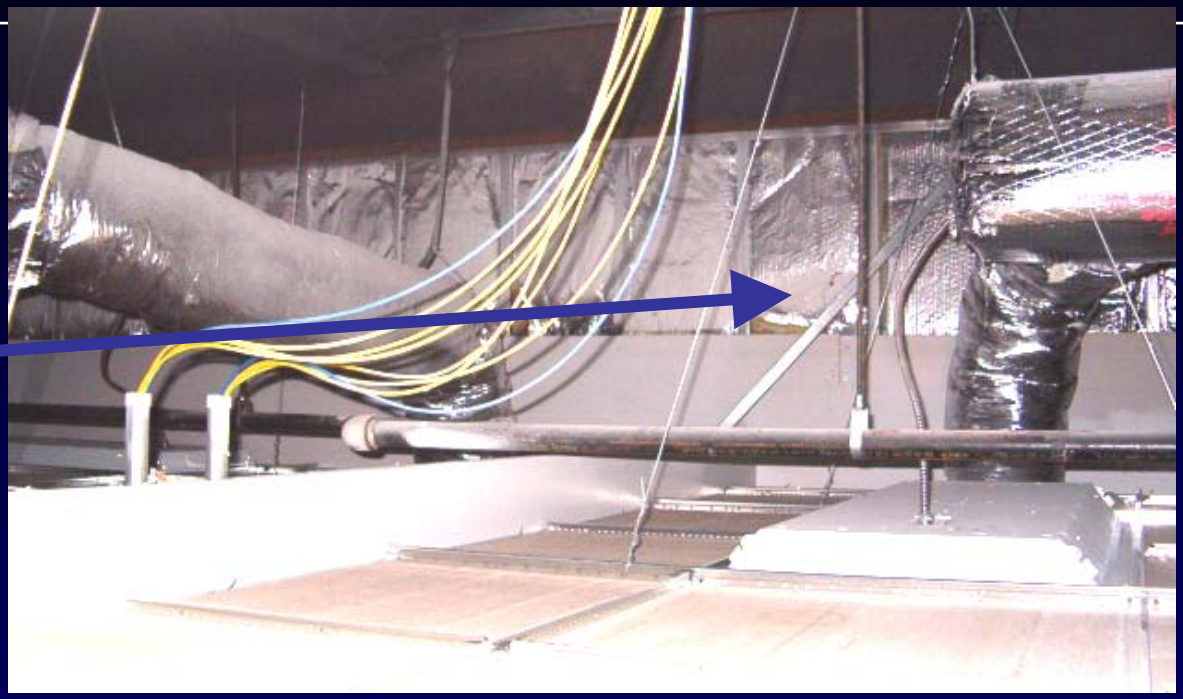
- Cavities above suspended ceilings
- Plenum return spaces (Highly depressurized)
- Ventilated walls
- Equipment tunnels and chases
- Mechanical rooms and mezzanines
- Unconditioned adjacent space (Storage, warehouse, plant, etc.)
- Exhaust and ventilation fans, plus wind and stack effect, are major driving forces

•Return Plenum Problems - Canopy



Is Air Barrier Continuous?

- Brand-new NC building
- Drywall left off of exterior wall above dropped ceiling
- Building uses above-ceiling area as return

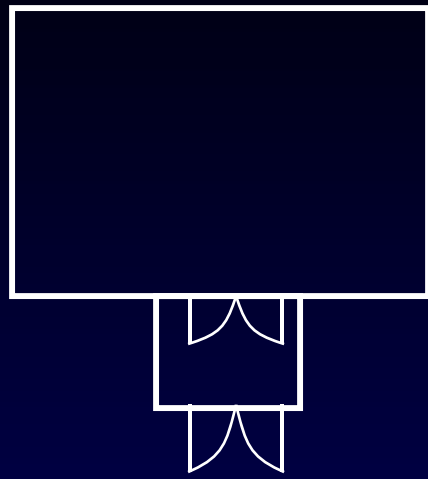


- When HVAC operates, entire wall cavity goes to a negative pressure, increasing air leakage, effectively reducing insulation value, and potentially causing moisture problems

Limiting Air Leakage Pathways

- Materials and connections must:
  - *stop air flow*
  - *withstand jobsite abuses*
  - *withstand forces of wind and pressure*
- Penetrations must be sealed
  - *plumbing, wiring, communications*
  - *ductwork*
  - *windows and doors*
- Functional penetrations, such as air intakes for exhaust fans, must be dampered
- Vestibules (5 Stories or more, with exceptions)

Section 5 – Envelope -- Vestibules



Required at *building entrances*

Self closing doors

Exceptions:

a. *Building entrances* with revolving *doors*.

b. *Doors* not used as a *building entrance.*

c. *Doors* opening directly from a *dwelling unit*.

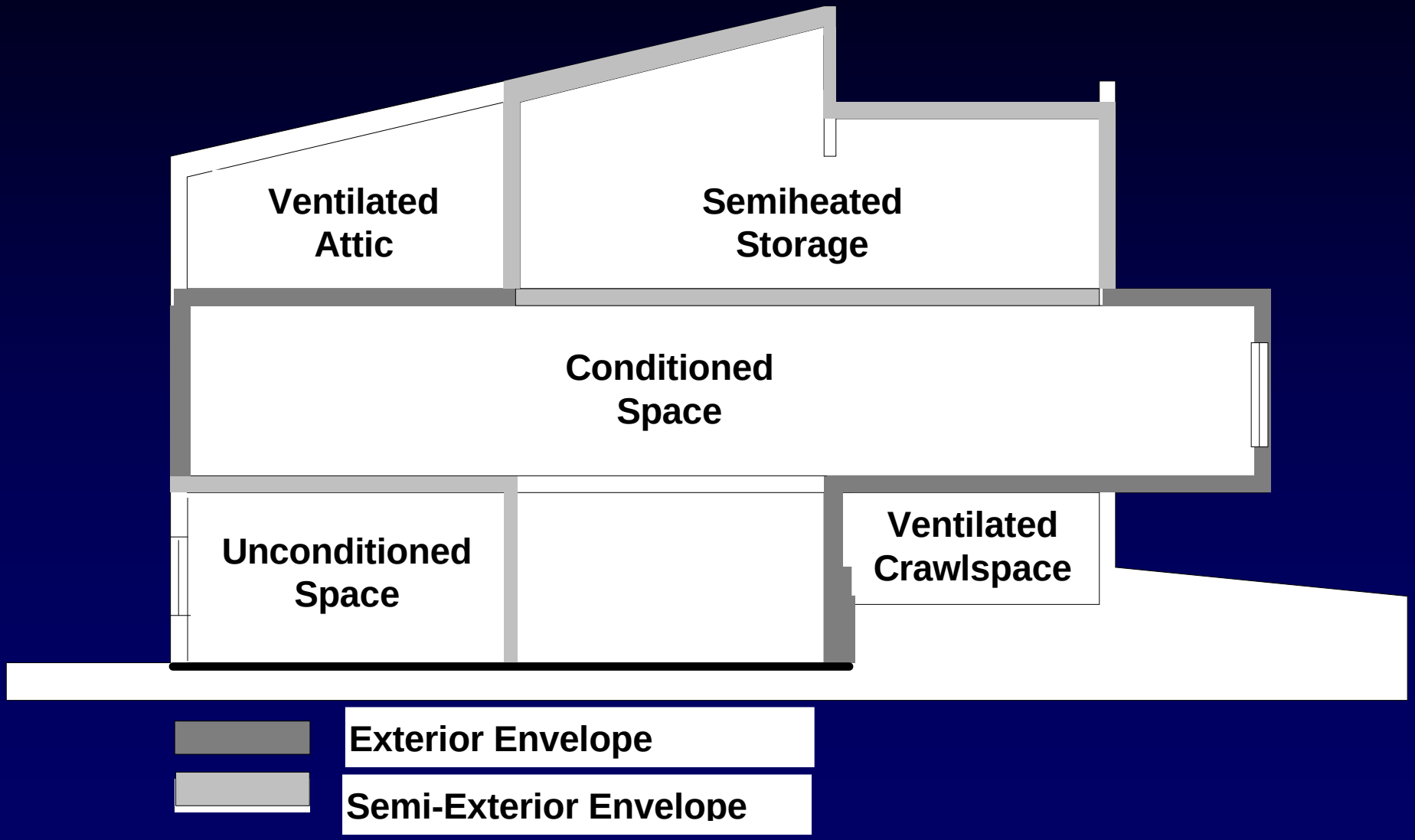
d. *Building entrances* in buildings located in climate zone 1 or 2.

e. *Building entrances* in buildings located in climate zone 3 or 4 that are less than four stories above grade and less than 10,000 ft^2 in area.

f. *Building entrances* in buildings located in climate zone 5, 6, 7, or 8 that are less than 1,000 ft^2 in area.

g. *Doors* that open directly from a *space* that is less than 3,000 ft^2 in area and is separate from the *building entrance*.

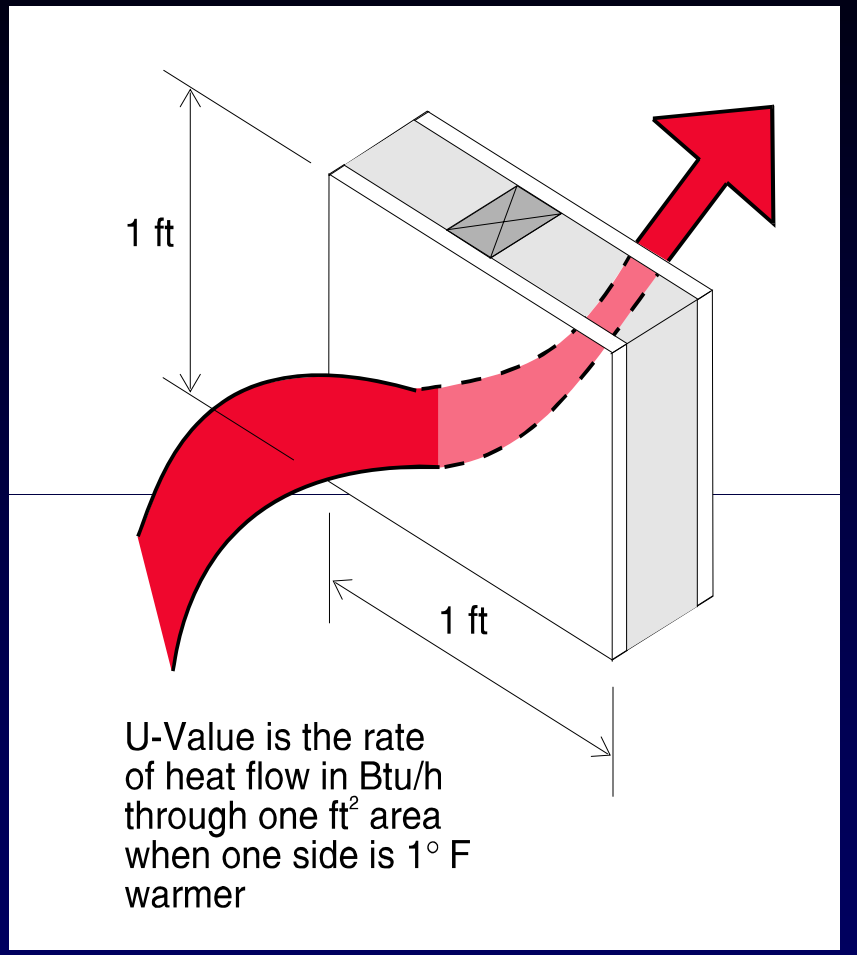
Section 5 - Prescriptive Requirements, Building Envelope



U-Factors

- The amount of heat in Btus (British thermal units) that flows each hour through one square foot, when there is a 1ºF temperature difference across the surface
- The smaller the number the better

$$U\text{-}Factor = \frac{1}{R\text{-}Value}$$

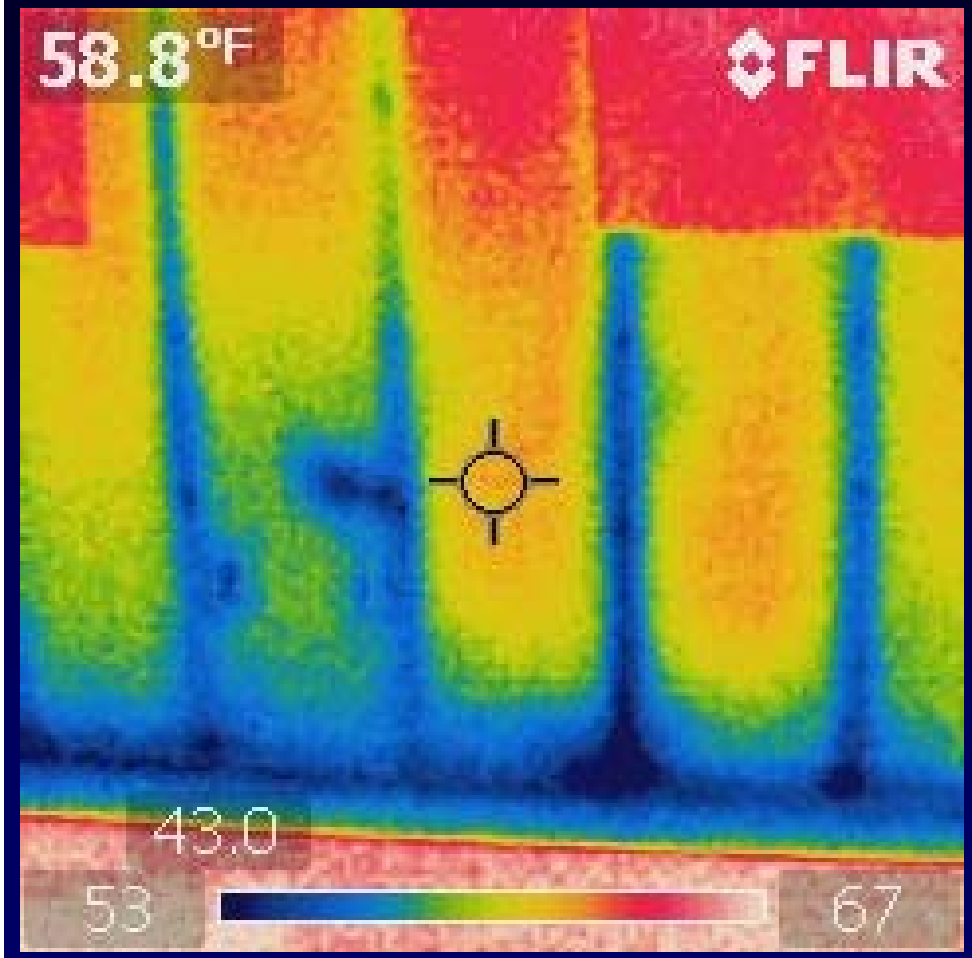


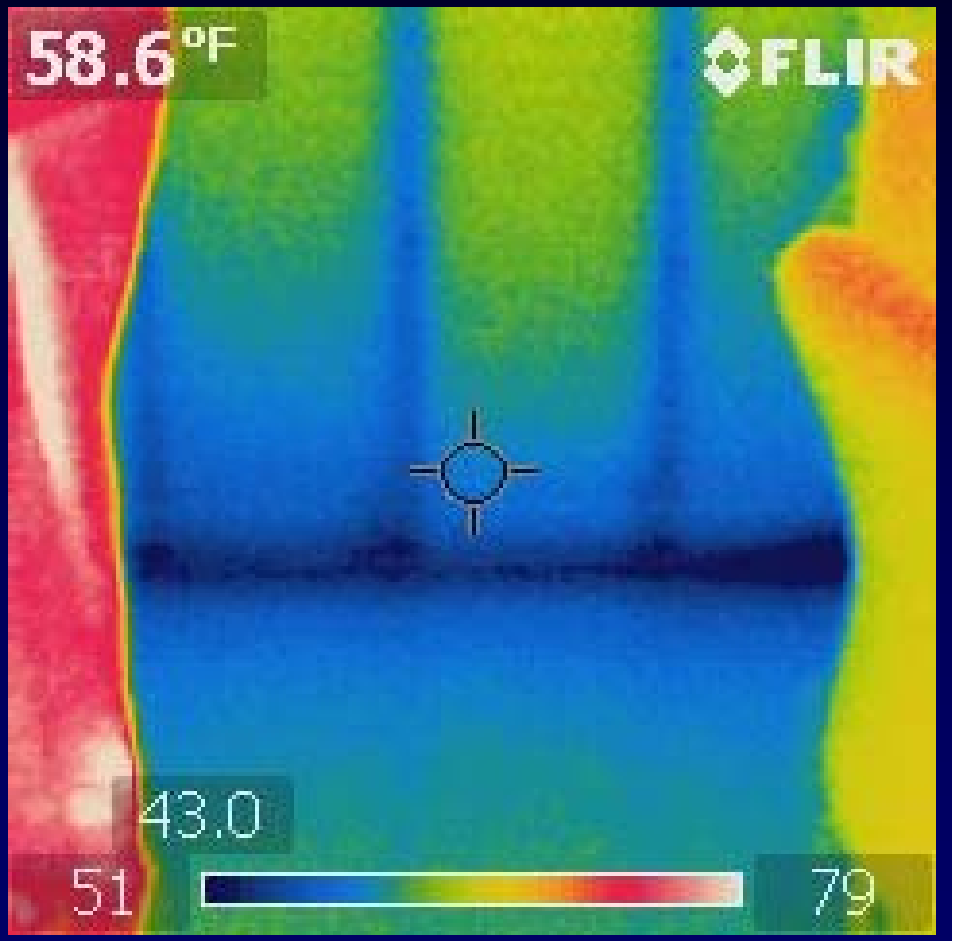
Common R-values – Resistance to Conductive Heat Flow

Concrete	*0.2 per inch*
½” Drywall	*0.5*
Double-paned glass	*1.8*
Low-e glass	*about 3.0*
Fiberglass insulation	*3 to 4 per inch*
Cellulose insulation	*3.7 per inch*
Expanded polystyrene	*4 per inch*
Extruded polystyrene	*5 per inch*
Icynene foam	*3.6 to 3.7 per inch*
Polyurethane foam	*6.7 to 7.0 per inch*

Steel Framing and Insulation

Thermal Losses from Steel Stud Walls

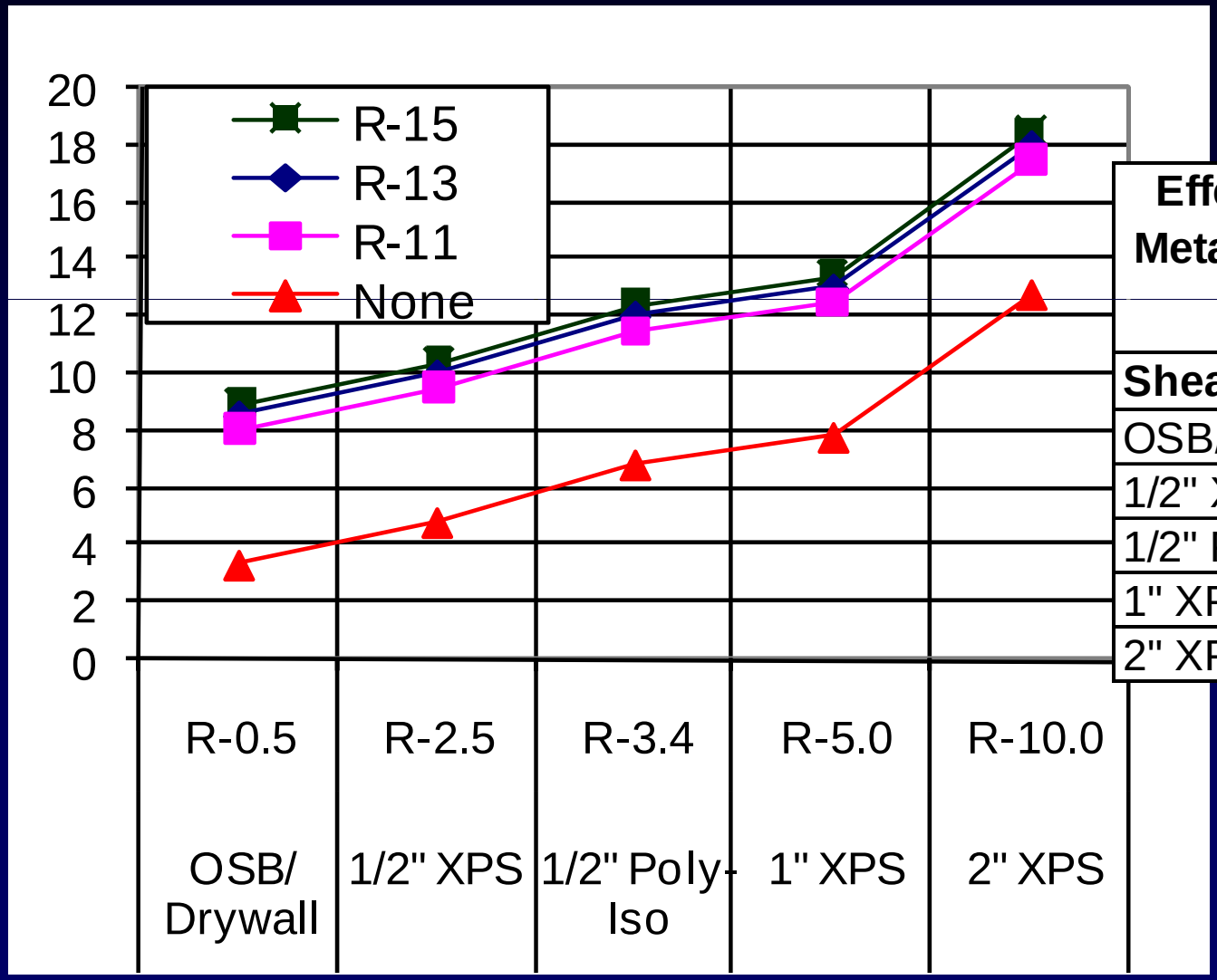




U-factors for Metal Stud Walls

Nominal R-value	Effective R-value	U-factor	Continuous Insulated Sheathing		
			1/2" EPS R-2.0	5/8" Poly-Iso R-4.0	1" XPS R-5.0
2 x 4 Metal Framing at 16 inches on Center (3.5 in cavity depth)					
None	(0.0)	0.352	0.207	0.146	0.128
R-11	(5.5)	0.132	0.105	0.087	0.080
R-13	(6.0)	0.124	0.100	0.083	0.077
R-15	(6.4)	0.118	0.096	0.080	0.074
2 x 4 Metal Framing at 24 inches on Center (3.5 in cavity depth)					
R-11	(6.6)	0.116	0.094	0.079	0.073
R-13	(7.2)	0.108	0.089	0.075	0.070
R-15	(7.8)	0.102	0.084	0.072	0.067

Effective R-value of 2x4 Metal Framed Walls (16” o.c.)

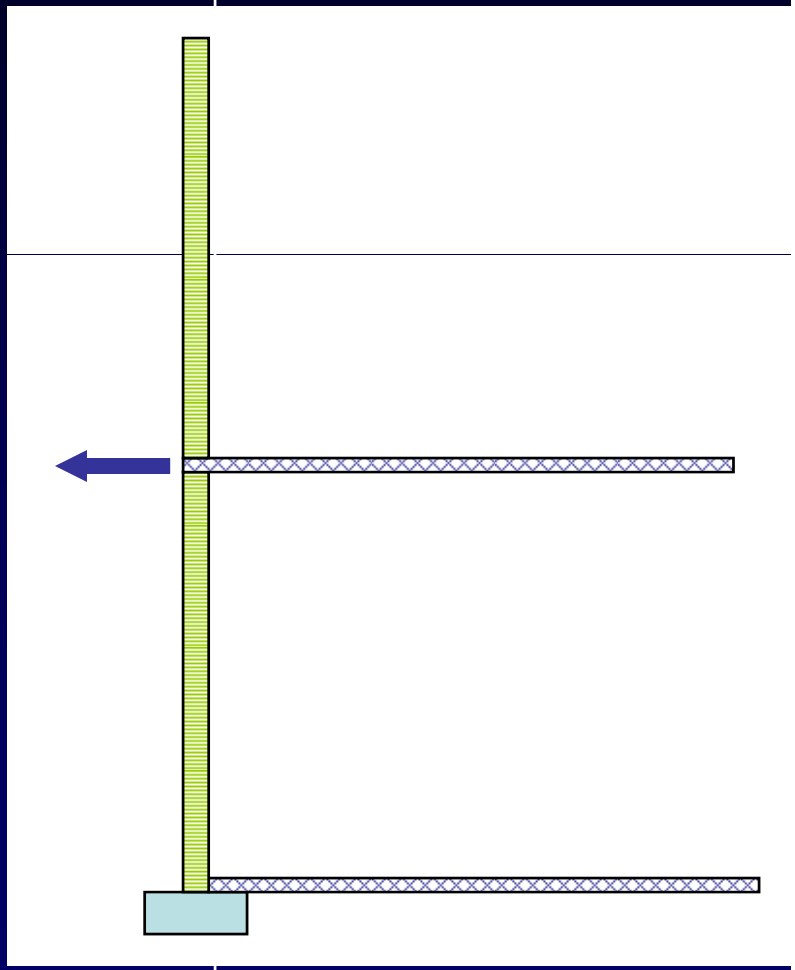


Effective R-Value of 2x4 Metal Framed Wall with R-13 Batt Insulation

Sheathing	R-value
OSB/ Drywall	8.1
1/2" XPS	9.5
1/2" Poly-Iso	11.5
1" XPS	12.5
2" XPS	17.5

Above Grade Floors – Is the Insulation Missing?

- Continuous insulation is the key
- 1” of foam is vital for exposed slab edges
- Heat loss will be more than just 4” of missing insulation
- Trace other potential discontinuities in wall insulation system

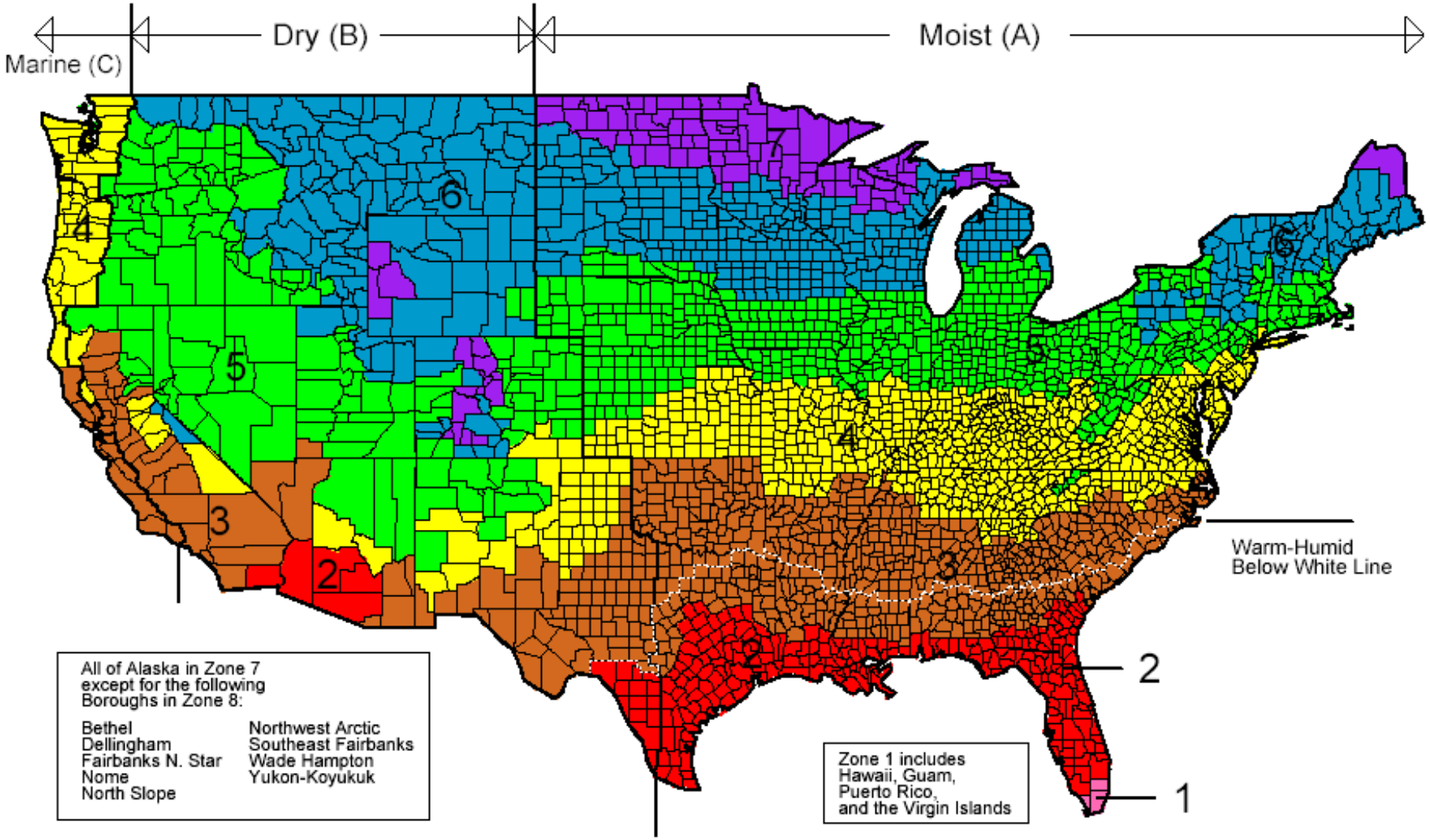


Make Insulation Continuous

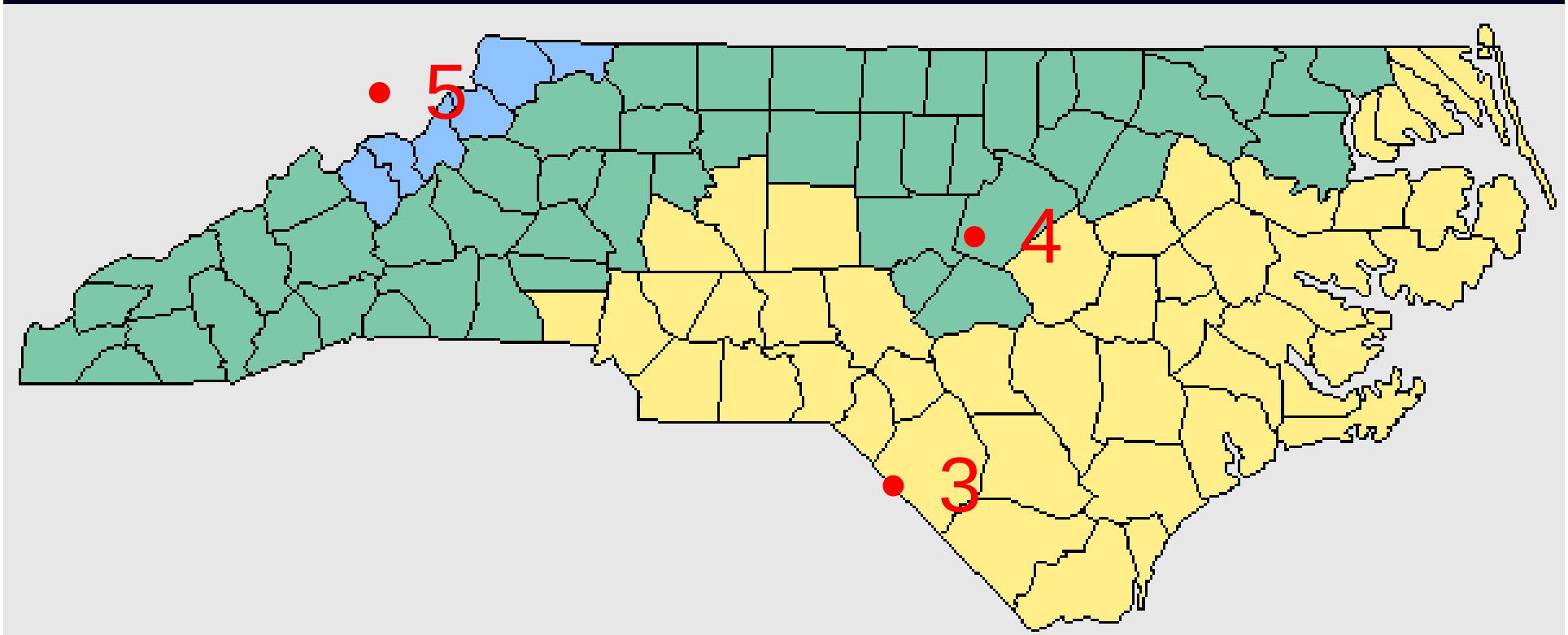
- Block walls -- should be insulated; insulating cores very ineffective
- Floors over unheated spaces, such as parking areas, need insulation
- For discontinuities in walls, such as offset areas for stairwells, elevators, and other spaces, the exterior envelope must be determined. The envelope requires both insulation and air sealing.

2006 IECC Climate Zones:

Zones 4 and Below Don't Require Wall Vapor Barriers (Only NW Mountains need one)



2009 NCECC



Roof Insulation Requirements:
IECC 2003 (Chapter 8 of current code)

IECC (Chapter 8): Roof Insulation Requirements

	Maximum Glazing Area							
	10%		25%		40%		50%	
	Cavity Insulation	Continuous Insulation	Cavity Insulation	Continuous Insulation	Cavity Insulation	Continuous Insulation	Cavity Insulation	Continuous Insulation
All-wood joist/truss	R-19	R-14	R-19	R-16	R-25	R-19	R-25	R-19
Metal joist/truss	R-19	R-15	R-25	R-17	R-25	R-20	R-25	R-20
Concrete slab or deck	NA	R-14	NA	R-16	NA	R-19	NA	R-19
Metal purlin with thermal block	R-25	R-15	R-25	R-17	R-30	R-20	R-30	R-20
Metal purlin without thermal block	X	R-15	X	R-17	X	R-20	R-30	R-20

Roof Insulation Requirements:
ASHRAE 90.1-2004 (Chapter 7 of current code and Chapter 5, section 501 of new code)

Table 5.5-3 ASHRAE 90.1-2004			
	Nonresidential	**Residential**	**Semiheated**
ASHRAE 90.1-2004 (Chapter 5)			
Nonresidential			
Roof	**Zone 3**	**Zone 4**	**Zone 5**
Insulation Entirely above Deck	R-15 c.i.*	R-15 c.i.*	R-15 c.i.*
Metal Building	R-19.0	R-19.0	R-19.0
Attic and Other	R-30.0	R-30.0	R-30.0
Residential			
Roof	**Zone 3**	**Zone 4**	**Zone 5**
Insulation Entirely above Deck	R-15.0 c.i.	R-15.0 c.i.	R-15.0 c.i.
Metal Building	R-19.0	R-19.0	R-19.0
Attic and Other	R-38.0	R-38.0	R-38.0
Semiheated			
Roof	**Zone 3**	**Zone 4**	**Zone 5**
Insulation Entirely above Deck	R-4.0 c.i.	R-4.0 c.i.	R-5.0 c.i.
Metal Building	R-10.0	R-10.0	R-10.0
Attic and Other	R-13.0	R-13.0	R-19.0
* c.i. = continuous insulation -- typically foam			

Roof Insulation Requirements:
IECC 2003 (Chapter 8 of current code)

	Climate Zone		
Roofs	**3**	**4**	**5**
Insulation entirely above deck	R-15, c.i.	R-15, c.i.	R-20, c.i.
Metal buildings (with R-5 thermal blocks)	R-19	R-19	R-19
Attic and other	R-30	R-30	R-30

Roofs for Metal Buildings:

R-19 + R-10 Filled cavity roof -- Thermal blocks are a minimum, R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin. This construction is R-10 insulation batts draped perpendicularly over the purlins, with enough looseness to allow R-19 batt to be laid above it, parallel to the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins. In the metal building industry, this is known as the “sag and bag” insulation system.

R-19: Standing seam with single insulation layer. Thermal blocks are a minimum R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin. This construction R-19 insulation batts draped perpendicularly over the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins.

Building Envelope Example: Roofs

No longer counts: Batts over suspended ceiling tiles

Inspection is Critically Important!

- Insulation specification was R-30 foam on roof deck according to the plans (and HVAC design)
- The 2.5 inches found installed in the field would only provide about R-15

Commercial Wall Requirements:
ASHRAE 90.1-2004 (Chapter 7 of current code and Chapter 5, Section 501 of new code)

Nonresidential	Zone 3	Zone 4	Zone 5
Walls, Above Grade			
Mass	R-5.7 c.i.	R-5.7 c.i.	R-7.5 c.i.
Metal Building	R-13	R-13	R-13
Steel Framed	R-13	R-13	R-13 + R-4 c.i.
Wood Framed and Other	R-13	R-13	R-13
Below Grade Wall	NR	NR	NR
Residential			
Walls, Above Grade			
Mass	R-7.3 c.i.	R-10 c.i.	R-11 c.i.
Metal Building	R-13	R-13	R-13 + R-13 c.i.
Steel Framed	R-13 + R-4 c.i.	R-13 + R-7 c.i.	R-13 + R-7 c.i.
Wood Framed and Other	R-13	R-13	R-13
Below Grade Wall	NR	NR	NR
Semiheated			
Walls, Above Grade			
Mass	NR	NR	NR
Metal Building	R-6	R-10	R-11.0
Steel Framed	NR	R-13	R-13.0
Wood Framed and Other	R-13	R-13	R-13.0
Below Grade Wall	NR	NR	NR

Commercial Wall Insulation Requirements:
IECC 2006 (Chapter 5 of new code)

	Climate Zone		
Walls, Above Grade	**3**	**4**	**5**
Mass	R-5.7 c.i.	R-5.7 c.i.	R-7.6 c.i.
Metal building	R-13	R-13	R-13+R-13
Metal framed	R-13	R-13	R-13+R-3.8 c.i.
Wood framed and other	R-13	R-13	R-13
Walls, Below Grade	NR	NR	NR

Walls for Metal Buildings:

R-13 Single insulation layer: The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.

R-13 + R-13 Double insulation layer: The first layer of R-13 insulation batts is installed continuously perpendicular to the girts, and is compressed as the metal skin is attached to the girts. The second layer of R-13 insulation batts is installed within the framing cavity.

Typical? Non-Compliant!

How about now?

Commercial Floor Requirements:
ASHRAE 90.1-2004 (Chapter 7 of current code and Chapter 5, Section 501 of new code)

ASHRAE 90.1-2004			
Nonresidential	**Zone 3**	**Zone 4**	**Zone 5**
Floors			
Mass	R-6.3 c.i.	R-6.3 c.i.	R-8.5 c.i.
Steel Joist	R-19	R-19	R-19
Wood Framed and Other	R-19	R-19	R-30
Slab-On-Grade Floors			
Unheated	NR	NR	NR
Heated	R-7.5, 12 in.	R-7.5, 24 in.	R-10, 36 in.
Opaque Doors			
Swinging	U-0.700	U-0.700	U-0.700
Non-Swinging	U-1.450	U-1.450	U-1.450

Residential	**Zone 3**	**Zone 4**	**Zone 5**
Floors			
Mass	R-8.3 c.i.	R-8.3 c.i.	R-10 c.i.
Steel Joist	R-19	R-30	R-30
Wood Framed and Other	R-30	R-30	R-30
Slab-On-Grade Floors			
Unheated	NR	NR	NR
Heated	R-7.5, 24 in.	R-10, 36 in.	R-10, 36 in.
Opaque Doors			
Swinging	U-0.700	U-0.700	U-0.700
Non-Swinging	U-1.450	U-0.500	U-0.500

Commercial Floor Requirements:
IECC 2006 (Chapter 5 of new code)

Floors	Zone 3	Zone 4	Zone 5
Mass	R-5 c.i.	R-10 c.i.	R-10 c.i.
Joist/ Framing	R-19	R-19	R-19
Slab-on-Grade Floors			
Unheated slabs	NR	NR	
Heated slabs	R-7.5 (12 in vert)	R-7.5 (12 in vert)	R-7.5 (24 in vert)

Section 5 – Compliance

Meet or exceed minimum R-values in Table 5.3

- *Only R-value of insulation, not to include air films, etc. OR*
- *Meet maximum U-factor, C-factor, or F-factor for the entire assembly OR*
- *Perform area-weighted average U-factor, C-factor, or F-factor*

Glazing Area Percentage

- Glazing percentage to Above Grade Wall
  - *Gross window area / gross wall area*
  - *Gross wall area includes*
    - Above-grade walls
    - Band joist and subfloor between floors
    - Area of all doors and windows

NFRC Label

National Fenestration Rating Council®
CERTIFIED

World's Best Window Co.

Millennium 2000+
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: **Vertical Slider**

ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.35	**0.32**

ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance	Air Leakage (U.S./I-P)
0.51	**0.2**

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.
www.nfrc.org

Section 802.2.3

IECC 2006 Commercial Glazing Requirements (new code)

Vertical Fenestration (40% maximum of above-grade walls)			
Required U-factors	**Zone 3**	**Zone 4**	**Zone 5**
Framing materials other than metal	0.65	0.4	0.35
Metal framed windows with or without thermal break			
Curtain Wall/ Storefront	0.6	0.5	0.45
Entrance Door	0.9	0.85	0.8
All Other	0.65	0.55	0.55
Solar Heat Gain Coefficient			
SHGC: Projection Factor <0.25	0.25	0.4	0.4
SHGC: 0.25 to 0.50	0.33	NR	NR
SHGC: >= 0.5	0.4	NR	NR

ASHRAE 90.1-2004 (Chapter 5)

Fenestration Values for Climate Zone 3

Window-Wall Ratio	Nonresidential	Residential	Semiheated
0-10.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
10.1-20.0%	U_{fixed}-0.57, $SHGC_{all}$-0.25	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
20.1-30.0%	U_{fixed}-0.57, $SHGC_{all}$-0.25	U_{fixed}-0.57, $SHGC_{all}$-0.25	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.39	U_{oper}-0.67, $SHGC_{north}$-0.39	U_{oper}-1.27, $SHGC_{north}$- NR
30.1-40.0%	U_{fixed}-0.57, $SHGC_{all}$-0.25	U_{fixed}-0.57, $SHGC_{all}$-0.25	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.39	U_{oper}-0.67, $SHGC_{north}$-0.39	U_{oper}-1.27, $SHGC_{north}$- NR
40.1-50.0%	U_{fixed}-0.46, $SHGC_{all}$-0.19	U_{fixed}-0.46, $SHGC_{all}$-0.19	U_{fixed}-0.98, $SHGC_{all}$- NR
	U_{oper}-0.47, $SHGC_{north}$-0.26	U_{oper}-0.47, $SHGC_{north}$-0.26	U_{oper}-1.02, $SHGC_{north}$- NR

U_{fixed} = U-value of fixed windows; U_{oper} = U-value of operable windows

$SHGC_{all}$ = Solar Heat Gain Coefficient of all windows

$SHGC_{north}$ = Solar Heat Gain Coefficient of north windows

Fenestration Values for Climate Zone 4

Window-Wall Ratio	Nonresidential	Residential	Semiheated
0-10.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
10.1-20.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
20.1-30.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
30.1-40.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-0.57, $SHGC_{all}$-0.39	U_{fixed}-1.22, $SHGC_{all}$- NR
	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-0.67, $SHGC_{north}$-0.49	U_{oper}-1.27, $SHGC_{north}$- NR
40.1-50.0%	U_{fixed}-0.46, $SHGC_{all}$-0.25	U_{fixed}-0.46, $SHGC_{all}$-0.25	U_{fixed}-0.98, $SHGC_{all}$- NR
	U_{oper}-0.47, $SHGC_{north}$-0.36	U_{oper}-0.47, $SHGC_{north}$-0.36	U_{oper}-1.02, $SHGC_{north}$- NR

ASHRAE 90.1 Fenestration Requirements for Climate Zones 3 and 4

Note: ASHRAE 90.1-2004 is an option for the current and new codes

Product Information and Installation *(Section 5.8)*

Insulation (5.8.1)

- *Not compressed*
- *Substantial contact/supported*
- *Recessed equipment if >1%*
- *Not above suspended ceilings*
- *Insulation needs to be protected*

Organization of ASHRAE Standard 90.1-2004

1 Purpose

2 Scope

3 Definitions

4 Administration and Enforcement

5 Building Envelope

6 Heating, Ventilating, and Air-Conditioning

7 Service Water Heating

8 Power

9 Lighting

10 Other Equipment

11 Energy Cost Budget Method

12 Normative References

Section 6 –
HVAC Key Concepts

- Goal – a system which minimizes system losses and utilizes free heating and cooling
- Scope and Compliance Paths
- Establish minimum equipment efficiencies
- Establish a min. level of control for systems
- Establish minimum levels of construction and insulation of systems.
- Simplified Approach/Prescriptive Path
- Submittals

Section 6 – HVAC
Scope (6.1.1)

- New Buildings – Mechanical equipment & systems serving HVAC needs of new buildings
- Additions – Same as new buildings
  - *Exception – if served by existing systems need not comply except for any new equipment or systems*
- Alterations –
  - *Replacement equipment – minimum efficiency only*
  - *New cooling for un-cooled spaces to comply*
  - *Alterations to cooling system not decrease economizer capability unless meets prescriptive requirements*
  - *New ductwork & piping to comply*
  - *Exceptions – repairs, refrigerant change, relocation, space constraints*

Section 6 – Simplified Approach Option

- Limited to buildings that meet the following criteria
  - *buildings with 1 or 2 stories*
  - *buildings < 25,000 ft2*
  - *single-zone systems*
  - *Unitary packaged or split system; air-cooled or evaporatively-cooled only; equipment efficiencies per tables*
  - *Economizer if required*
  - *Outside air requirements are less than 3000 CFM and less than 70% of airflow*
  - *Manual changeover or dual set-point thermostat*
  - *Heat pump supplementary control*
  - *No reheat or simultaneous heating and cooling for humidity control*

ASHRAE / IESNA 90.1-2004 Simplified Approach

1. Each system must serve a single zone.
2. Cooling shall be packaged or split system either air or evaporative cooled.
3. Economizers required in certain circumstances.
4. Heating shall be packaged or split system heat pump, gas, electric, or hot water.

ASHRAE / IESNA 90.1-2004 Simplified Approach (cont.)

5. Outside air requirements shall be less than 3,000 cfm and less than 70% of supply air quantity; or energy recovery system.
6. Requires manual changeover or dual set point thermostat.
7. When possible, heat pump feature will always provide heating.

ASHRAE / IESNA 90.1-2004 Simplified Approach (cont.)

8. No reheat or simultaneous heating and cooling.
9. Control for systems larger than 65,000 Btuh and ¾ HP fan motor require a time clock.
10. Piping insulation and weather protection.
11. Ductwork and plenum insulation.

ASHRAE / IESNA 90.1-2004 Simplified Approach (cont.)

12. Ducted systems air balanced to 10% of design.
13. Separate thermostats interlocked to prevent simultaneous heating and cooling.
14. Exhausts over 300 cfm shall have gravity or motor dampers.
15. System greater than 10,000 cfm shall have optimum start controls.

Condensation Challenges

- A/C ductwork: 50-65 0F
- Cooling below 71 0F
- Metal framing in winter
- Metal framing in summer
- Cool piping for chilled water

What Happened?

The large
hole in the

holes occur at the corners and along the top of the grille. Image 15)

Non-Code Compliant

Example; 25-ton: Cooling Efficiency

TABLE 6.2.1B
Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
Air Cooled (Cooling Mode)	<65,000 Btu/h[c]	All	Split System	10.0 SEER	ARI 210/240
			Single Package	9.7 SEER	
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.1 EER	
		All other	Split System and Single Package	9.9 EER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.3 EER	ARI 340/360
		All other	Split System and Single Package	9.1 EER	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.0 EER 9.2 IPLV	
		All other	Split System and Single Package	8.8 EER 9.0 IPLV	
Water-Source (Cooling Mode)	<17,000 Btu/h	All	86°F Entering Water	11.2 EER	ISO-13256-1
	≥17,000 Btu/h and <135,000 Btu/h	All	86°F Entering Water	12.0 EER	ISO-13256-1
Groundwater-Source (Cooling Mode)	<135,000 Btu/h	All	59°F Entering Water	16.2 EER	ISO-13256-1
Ground Source (Cooling Mode)	<135,000 Btu/h	All	77°F Entering Water	13.4 EER	ISO-13256-1

Example; 25 ton: Heating

TABLE 6.2.1B
Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
Air Cooled (Heating Mode)	<65,000 Btu/h[c] (Cooling Capacity)	–	Split System	6.8 HSPF	ARI 210/240
			Single Package	6.6 HSPF	
	≥65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	–	47°F db/43°F wb Outdoor Air	3.2 COP	
			17°F db/15°F wb Outdoor Air	2.2 COP	
	≥135,000 Btu/h (Cooling Capacity)	–	47°F db/43°F wb Outdoor Air	3.1 COP	ARI 340/360
			17°F db/15°F wb Outdoor Air	2.0 COP	
Water-Source (Heating Mode)	<135,000 Btu/h (Cooling Capacity)	–	68°F Entering Water	4.2 COP	ISO-13256-1
Groundwater-Source (Heating Mode)	<135,000 Btu/h (Cooling Capacity)	–	50°F Entering Water	3.6 COP	ISO-13256-1
Ground Source (Heating Mode)	<135,000 Btu/h (Cooling Capacity)	–	32°F Entering Water	3.1 COP	ISO-13256-1

[a] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
[b] IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.
[c] Single-phase, air-cooled heat pumps < 65,000 Btu/h are regulated by NAECA. SEER and HSPF values are those set by NAECA

Economizers in North Carolina

- IECC 2003 Chapter 7 (ASHRAE 90.1):
  - *Would be required in Asheville and high elevations*
- IECC 2003 Chapter 8:
  - *Economizers required in all zones except 1,2,3b,5a and 6b (meaning all of North Carolina except the coastal areas to Charlotte)*

Example; 25 ton: Duct Insulation

TABLE 6.2.4.2B
Minimum Duct Insulation R-Value,[a] Combined Heating and Cooling Ducts

Climate Zone			Duct Location						
Envelope Criteria Table	HDD65	CDD50	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic w/ Roof Insulation[a]	Uncon-ditioned Space[b]	Indirectly Condi-tioned Space[c]	Buried
B-9	1801-2700	0-5400	R-6	R-3.5	R-6	R-1.9	R-1.9	none	R-1.9
B-10	2701-3600	5401+	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-11	2701-3600	3601-5400	R-6	R-6	R-6	R-3.5	R-3.5	none	R-1.9
B-12	2701-3600	0-3600	R-3.5	R-3.5	R-3.5	R-1.9	R-1.9	none	R-1.9
B-13	3601-5400	3601+	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-14	3601-5400	1801-3600	R-6	R-3.5	R-6	R-1.9	R-3.5	none	R-1.9
B-15	3601-5400	0-1800	R-3.5	R-3.5	R-3.5	R-1.9	R-1.9	none	R-1.9
B-16	5401-7200	3601+	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-17	5401-7200	1801-3600	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
B-18	5401-7200	0-1800	R-6	R-3.5	R-3.5	R-1.9	R-3.5	none	R-3.5

Example; 25 ton: Ducts

- Table 6-D in User Manual
- R-3.5: 1-inch duct liner, fiberboard, duct board, flex duct; 1.5-inch mineral fiber duct wrap
- R-6.0: 1.5-inch duct liner, fiberboard, duct board, flex duct; 2.5-inch flex duct, mineral fiber duct wrap
- R-8.0: 2-inch duct liner, fiberboard, duct board, flex duct; 3-inch flex duct, mineral fiber duct wrap
- Duct Sealing Required (to be discussed later)

Example; 25 ton: Other

- Air Balancing – add note to the design drawings or specs calling for balancing according to ASHRAE 111, NEBB, AABCm or other industry-recognized standard
- Since no fan exceeds 300 cfm, a backdraft damper is not required per 6.2.3.3.3

ASHRAE / IESNA 90.1-2004

HVAC Mandatory Provisions

- Applies to the Prescriptive Path and the Energy Cost Budget method
- Requirements address…
  - *Life cycle cost analysis*
  - *Equipment efficiencies*
  - *Load calculations*
  - *Controls*
  - *Construction and insulation*
  - *Completion requirements*

Constant vs. Variable Speed Systems

- Constant speed fans and pumps, constant temperature heating and cooling systems and constant volume ventilation and exhaust systems are efficient only at full load conditions.
- Variable systems are efficient at part loads.
- Motors: Multiple speed, modular, variable speed.
- Supply Air: Bypass, variable air volume.
- Supply temperature: Reset based on demand or outdoor air temperature.
- Outdoor air: Reset based on occupancy.
- Primary heating and cooling equipment: staged, modular.

Section 6.4

Section 6
Mechanical Equipment Efficiency

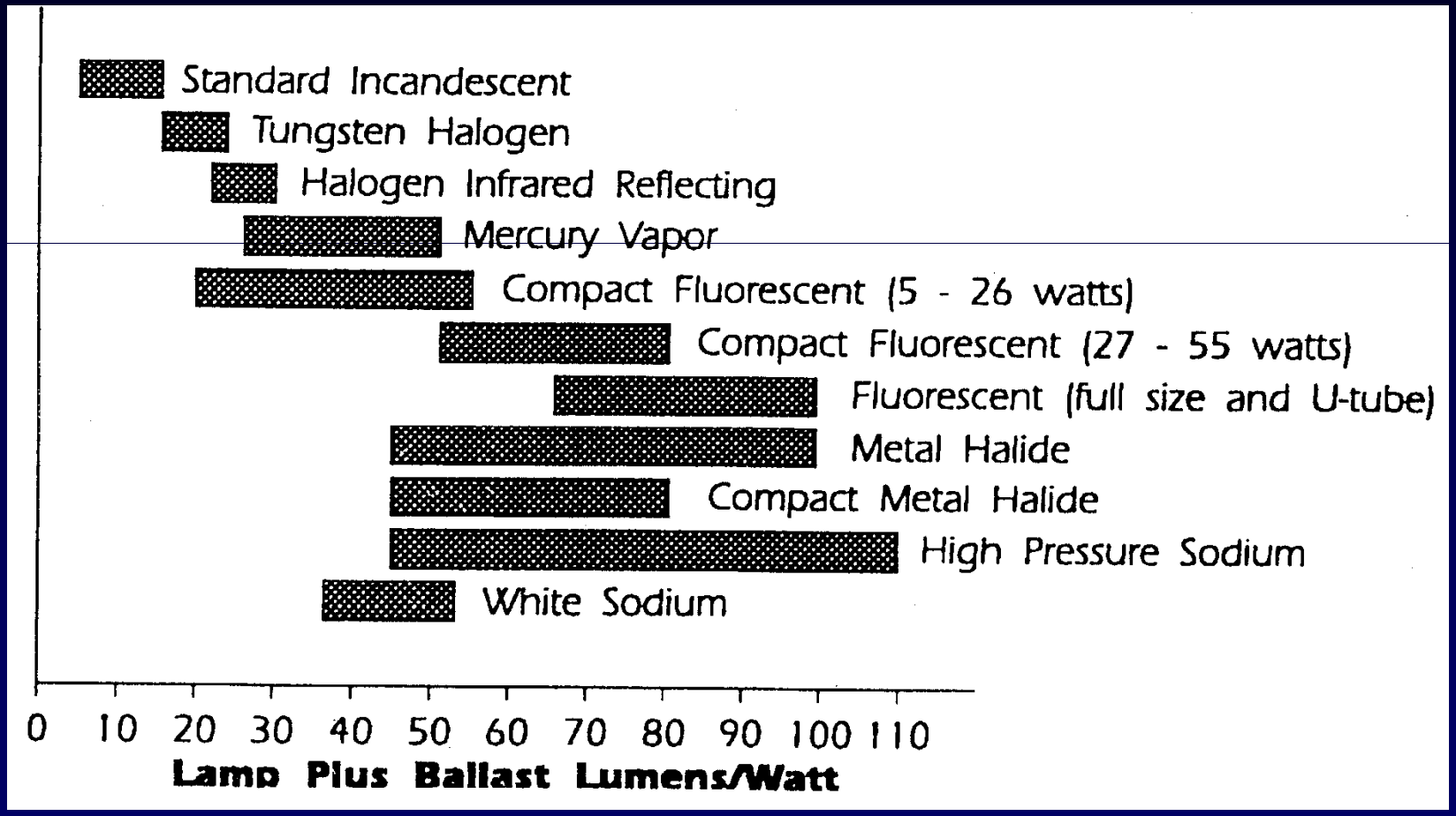
- Air conditioners & Condensing Units
- Heat Pumps
- Water Chilling Packages – standard conditions
- Packaged Terminal and Room Air Conditioners & Heat Pumps
- Furnaces, Duct Furnaces and Unit Heaters
- Boilers
- Heat Rejection Equipment

Section 6
Load Calculations

- Load Calculations are required!
  - *Ask for them!*

Section 9 – Lighting

Energy-Efficient Lighting Sources


Standard Incandescent
Tungsten Halogen
Halogen Infrared Reflecting
Mercury Vapor
Compact Fluorescent (5 - 26 watts)
Compact Fluorescent (27 - 55 watts)
Fluorescent (full size and U-tube)
Metal Halide
Compact Metal Halide
High Pressure Sodium
White Sodium
0 10 20 30 40 50 60 70 80 90 100 110
Lamp Plus Ballast Lumens/Watt

Lighting Power Densities Using the Building Area Method

Building Area Type[a]	Lighting Power Density (Watt/ft^2)
Automotive Facility	1.5
Convention Center	1.4
Court House	1.4
Dining: Bar, Lounge/ Leisure	1.5
Dining: Cafeteria/ Fast Food	1.8
Dining: Family	1.9
Dormitory	1.5
Exercise Center	1.4
Gymnasium	1.7
Hospital/Health Care	1.6
Hotel	1.7
Library	1.5
Manufacturing Facility	2.2
Motel	2.0
Motion Picture Theater	1.6
Office	1.3
Parking Garage	0.3
Penitentiary	1.2
Performing Arts Theater	1.5
Police/Fire Station	1.3
Post Office	1.6
Religious Building	2.2
Retail	1.9
School/University	1.5
Sports Arena	1.5
Town Hall	1.4
Transportation	1.2
Warehouse	1.2

Does the Building Comply?

- Determine the total connected power in watts for the proposed lighting
- Determine the interior lighting power budget for the entire building or space
- Building complies if:
  - *Interior lighting power budget - total connected power ≥ 0*

Exterior Lighting

- Criteria
  - *Lighting power supplied through building electrical service*
  - *Must use energy-efficient lighting sources to highlight paths, walkways and parking areas*
    - ≥ 45 Lumens/Watt
    - Fluorescent or Compact Fluorescent
    - Metal Halide or High Pressure Sodium
- Exceptions
    - Historical
    - Safety
    - Signage
    - Emergency

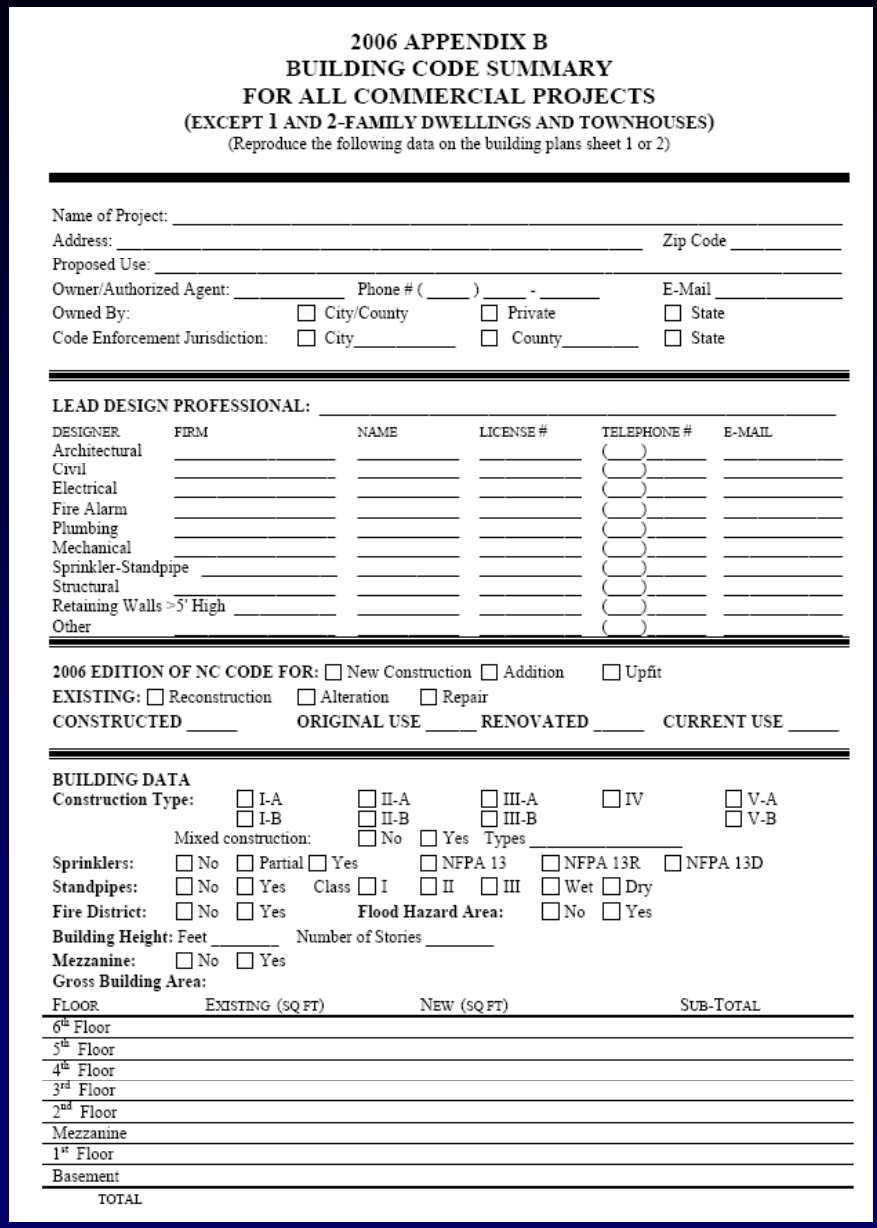
•Section 805.5/805.6

Section 11
Energy Cost Budget Method

- Alternative to prescriptive method except buildings with no mechanical systems
- Based on overall building performance expressed as “energy cost budget”
- Mandatory Provisions all must be met
- Budget (or baseline) based on prescriptive measures
- Allows trade-offs between measures
- Useful for optimizing design

So, What Now?

- In Commercial, Appendix B is <u>not enough</u>
- Plan review and inspection of energy features is needed



2006 APPENDIX B
BUILDING CODE SUMMARY
FOR ALL COMMERCIAL PROJECTS
(EXCEPT 1 AND 2-FAMILY DWELLINGS AND TOWNHOUSES)
(Reproduce the following data on the building plans sheet 1 or 2)

Name of Project: _____
Address: _____ Zip Code _____
Proposed Use: _____
Owner/Authorized Agent: _____ Phone # (____) ____ - _____ E-Mail _____
Owned By: ☐ City/County ☐ Private ☐ State
Code Enforcement Jurisdiction: ☐ City_____ ☐ County_____ ☐ State

LEAD DESIGN PROFESSIONAL: _____

DESIGNER	FIRM	NAME	LICENSE #	TELEPHONE #	E-MAIL
Architectural				(___)___	
Civil				(___)___	
Electrical				(___)___	
Fire Alarm				(___)___	
Plumbing				(___)___	
Mechanical				(___)___	
Sprinkler-Standpipe				(___)___	
Structural				(___)___	
Retaining Walls >5' High				(___)___	
Other				(___)___	

2006 EDITION OF NC CODE FOR: ☐ New Construction ☐ Addition ☐ Upfit
EXISTING: ☐ Reconstruction ☐ Alteration ☐ Repair
CONSTRUCTED _____ **ORIGINAL USE** _____ **RENOVATED** _____ **CURRENT USE** _____

BUILDING DATA
Construction Type: ☐ I-A ☐ I-B ☐ II-A ☐ II-B ☐ III-A ☐ III-B ☐ IV ☐ V-A ☐ V-B
Mixed construction: ☐ No ☐ Yes Types _____
Sprinklers: ☐ No ☐ Partial ☐ Yes ☐ NFPA 13 ☐ NFPA 13R ☐ NFPA 13D
Standpipes: ☐ No ☐ Yes Class ☐ I ☐ II ☐ III ☐ Wet ☐ Dry
Fire District: ☐ No ☐ Yes **Flood Hazard Area:** ☐ No ☐ Yes
Building Height: Feet _____ Number of Stories _____
Mezzanine: ☐ No ☐ Yes
Gross Building Area:

FLOOR	EXISTING (SQ FT)	NEW (SQ FT)	SUB-TOTAL
6th Floor			
5th Floor			
4th Floor			
3rd Floor			
2nd Floor			
Mezzanine			
1st Floor			
Basement			
TOTAL			

Key Inspection Points

- Envelope
  - *Insulation values correct? Proper installation?*
  - *Fenestration -- % glass*
  - *Fenestration – U-factor and SHGC (on plans and in field)*
  - *Air sealing details*
- HVAC
  - *Programmable controls?*
  - *Economizer?*
  - *Duct and pipe insulation?*
  - *Ducts sealed?*

Key Inspection Points (cont.)

- HVAC (continued)
  - *No simultaneous heating and cooling (except where allowed for reheat)*
  - *Complex systems*
    - Fan power
    - Temperature reset
    - Zoning
    - Reheat limitation
    - Etc.
- Lighting
  - *If most lamps are not T-8 fluorescent or more efficient lamps, need to check*
  - *Check controls*
  - *Exit signs*
  - *Exterior lighting*

ASHRAE 90.1: Advanced Design Guide – Office Building

	ASHRAE 90.1 2004	Advanced Design Guide
Roof	**Zone 4**	**Zone 4**
Insulation Entirely above Deck	R-15 c.i.*	R-20 c.i.*
Metal Building	R-19.0	R-13 + 19
Attic and Other	R-30.0	R-38
Walls, Above Grade		
Mass	R-5.7 c.i.	R-11.4 c.i.
Metal Building	R-13	R-13
Steel Framed	R-13	R-13+R-7.5
Wood Framed and Other	R-13	R-13
Below Grade Wall	NR	NR
Floors		
Mass	R-8.3 c.i.	R-8.3 c.i.
Steel Joist	R-30	R-30
Wood Framed and Other	R-30	R-30

ASHRAE 90.1: Advanced Design Guide – Office Building

Fenestration Values for Climate Zone 4		
Window-Wall Ratio	**ASHRAE 90.1 2004**	**Advanced Design Guide**
0-10.0%	U_{fixed}-0.57, $SHGC_{all}$-0.39	Up to 40% of wall area
	U_{oper}-0.67, $SHGC_{north}$-0.49	U-0.42
10.1-	U_{fixed}-0.57, $SHGC_{all}$-0.39	SHGC - 0.46
	U_{oper}-0.67, $SHGC_{north}$-0.49	Area of north glass * SHGCn +
20.1-	U_{fixed}-0.57, $SHGC_{all}$-0.39	Area of south glass * SHGCs >
	U_{oper}-0.67, $SHGC_{north}$-0.49	Area of east glass * SHGCe +
30.1-	U_{fixed}-0.57, $SHGC_{all}$-0.39	Area of west glass * SHGCw
	U_{oper}-0.67, $SHGC_{north}$-0.49	South, east, west has overhang
40.1-	U_{fixed}-0.46, $SHGC_{all}$-0.25	
	U_{oper}-0.47, $SHGC_{north}$-0.36	

ASHRAE 90.1: Advanced Design Guide – Office Building

Interior Lighting	ASHRAE 90.1 2004	Advanced Design Guide
	1.30 Watts/. Sq ft	0.90 Watts/ sq ft
		90 lumen/ watt linear fluorescent
		Dimmable fixture within 12 ft of N/S window wall or within 8 ft of skylight edge
		Auto-off in all unoccupied rooms
		Reflectance of 80% on ceilings, 70% on walls and vertical partition

ASHRAE 90.1: Advanced Design Guide – Office Building

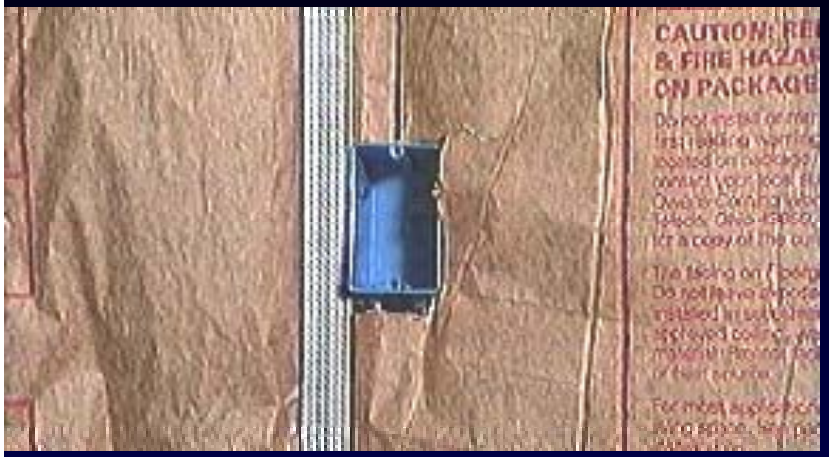
Cooling	ASHRAE 90.1 2004	Advanced Design Guide
0-65 kBtuh	10 SEER	13 SEER
65-135 kBtuh	10.3 EER/ 11.2 IPLV	11 EER/ 11.4 IPLV
135-240 kBtuh	9.7 EER/ 11.2 IPLV	10.8 EER/ 11.2 IPLV
> 240 kBtuh	9.5 EER/ 11.2 IPLV	10 EER/ 10.4 IPLV
Furnaces		
All sizes	80% AFUE	80% AFUE
Heat pumps		
0-65 kBtuh	10 SEER/ 6.8 HSPF	13 SEER/ 7.7 HSPF
65-135 kBtuh	10.1 EER	10.6 EER/ 11 IPLV
>135 kBtuh	9.3 EER/ 9.2 IPLV (>240)	10.1 EER/ 11 IPLV
Other	Economizers -- depend	Economizers > 54 kBtuh
	Ventilation controls	Motorized control with
	optional	CO_2 sensors
	Sealed ducts	Sealed ducts
		81% gas instantaneous water htr
		EF > 99%

ASHRAE 90.1: Advanced Design Guide – Office Building

	ASHRAE 90.1 2004	Advanced Design Guide
Roof	**Zone 4**	**Zone 4**
Insulation Entirely above Deck	R-15 c.i.*	R-20 c.i.*
Metal Building	R-19.0	R-13 + 19
Attic and Other	R-30.0	R-38
Walls, Above Grade		
Mass	R-5.7 c.i.	R-11.4 c.i.
Metal Building	R-13	R-13
Steel Framed	R-13	R-13+R-7.5
Wood Framed and Other	R-13	R-13
Below Grade Wall	NR	NR
Floors		
Mass	R-8.3 c.i.	R-8.3 c.i.
Steel Joist	R-30	R-30
Wood Framed and Other	R-30	R-30

Corners

Wall Insulation



Zone 11a: Wall Insulation Requirements (NC 2006 Code -- Chaper 8)

	Maximum Glazing Area			
	10%	25%	40%	10%
Wood Framing	R-11	R-11	R-11	R-11
Metal Framing	R-11	R-11	R-11	R-11
CMU with integral insulation	R-11/ R-5*	R-11/ R-5*	R-11/ R-5*	R-11/ R-5*
Other masonry walls	R-11	R-11	R-11	R-11

* R-11 metal or wood stud wall or R-5 continuous foam

Economizers (Simple)

- Air economizers required on systems if cooling capacity:
  - *> 90,000 Btu/h*
- Not required in climate zones:
  - *1, 2, 3b,5a or 6b*
- Not required if the cooling of proposed equipment meets or exceeds the EER listed in Table 803.2.6
- Zone 7 >135,000Btu/h

Not required on system with air or evaporative cooling condensers and which serve spaces with open case refrigeration or that require filtration equipment in order to meet the minimum ventilation requirements of Chapter 4 of IMC.

Section 803.2.6

Economizers (Simple)

- Trade-off high cooling efficiency for economizer
  - *Total cooling capacity*
  - *Climate zones*
  - *Equipment efficiency (EER)*

Table 803.2.6

Total Cooling Capacity of Equipment	Building Location		
	Zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15-1	Zones 3a, 3b, 4a, 7a, 8, 9b, 10b, 11b	Zones 4b, 5a, 5b, 6b, 7b
90,000 Btu/h to 134,999 Btu/h	N/A	11.4 EER	10.4 EER
135,000 Btu/h to 759,999 Btu/h	N/A	10.9 EER	9.9 EER
760,000 Btu/h or more	N/A	10.5 EER	9.6 EER

Section 803.2.6

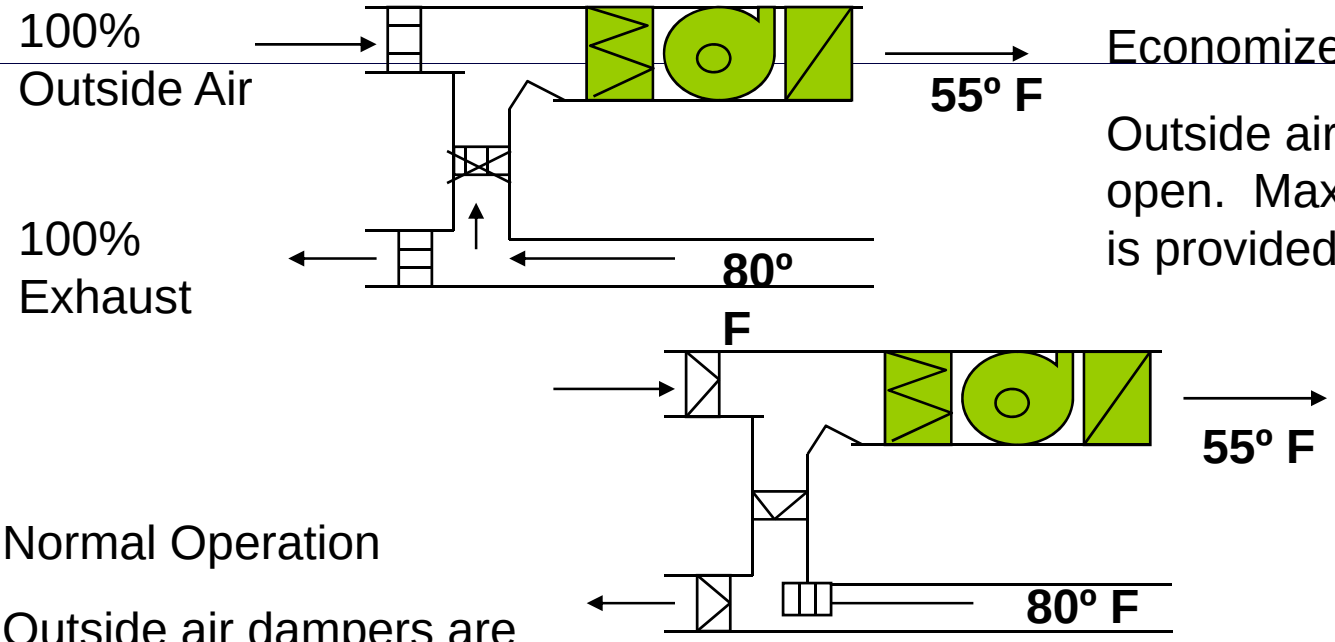
Economizers (Complex)

- In Accordance with Simple Requirements of Section 803.2.6
- Air economizers required on systems if cooling capacity:
  - *> 90,000 Btu/h*
  - > 65,000 Btu/h
- Not required in climate zones:
  - *1, 2, 3b*
  - 1, 2, 3b, 5a or 6b
- Exception
  - *Water economizers that can*
    - cool supply air by either direct or indirect evaporation or both and
    - provide up to 100% of expected system cooling load at outside air temperatures of 50°F dry bulb/45°F wet bulb and below
  - Not required in systems under 135,000 Btu/h cooling capacity in climate zones 3c, 5b, 7, 13b, 14

Section 803.3.3.5

Air-Side Economizers

- Use dampers to increase outside air when outside air cool system requires cooling



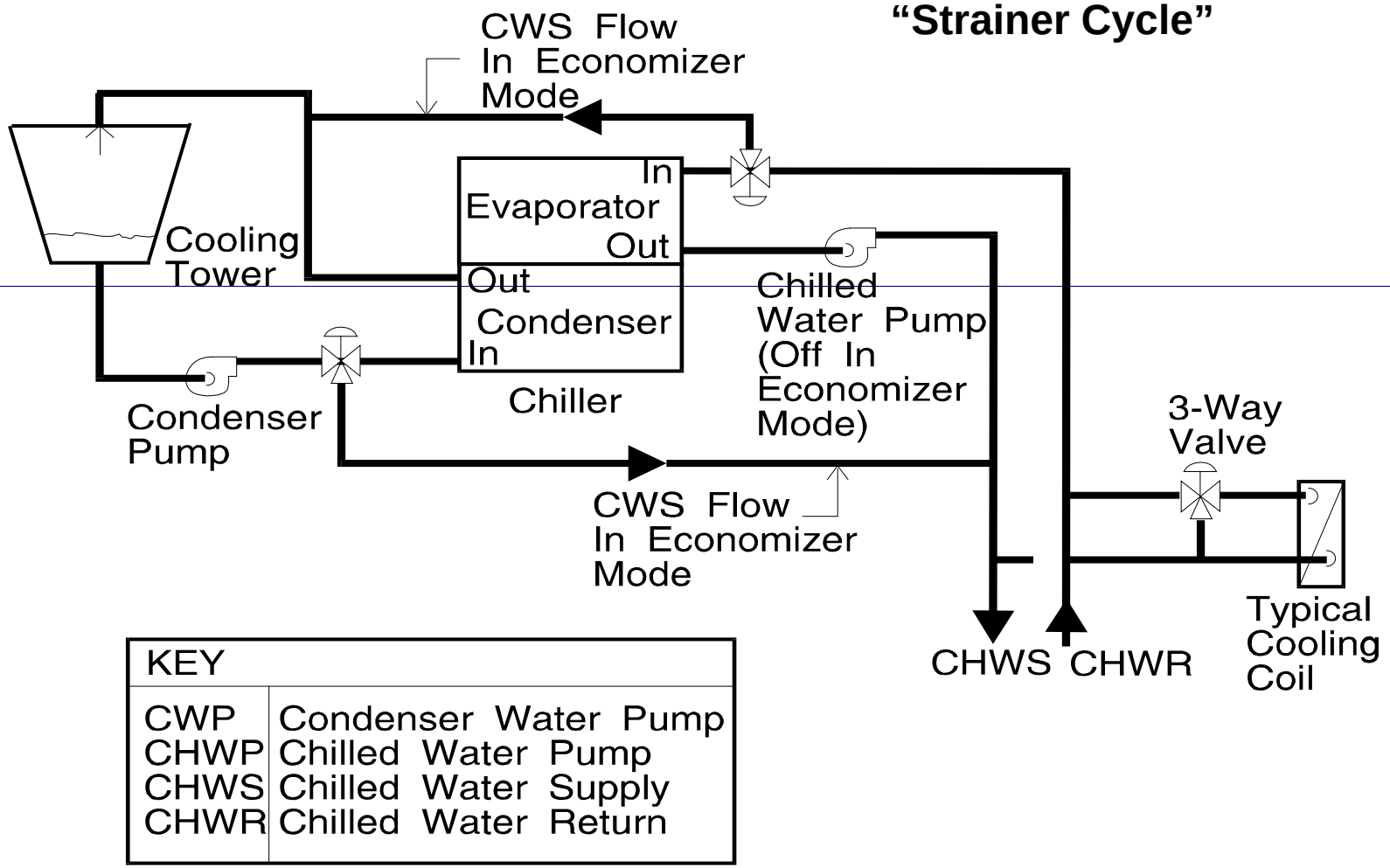
Economizer Operation

Outside air dampers are fully open. Maximum outside air is provided

Normal Operation

Outside air dampers are positioned to provide the minimum outside air

Water-Side Economizer



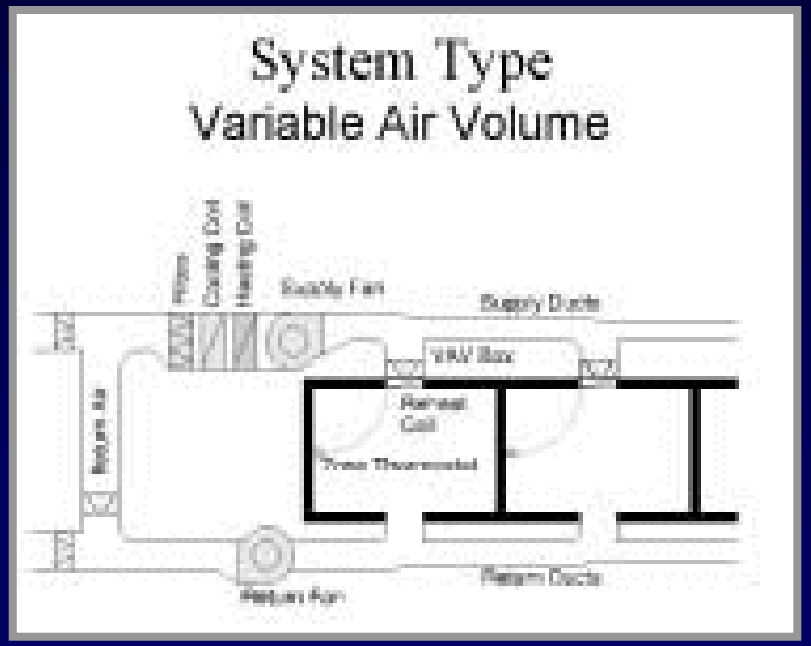
KEY	
CWP	Condenser Water Pump
CHWP	Chilled Water Pump
CHWS	Chilled Water Supply
CHWR	Chilled Water Return

Shutoff Dampers
(Simple and Complex)

- Required for outdoor-air and exhaust systems with design air flow rates > 3000 cfm
- Must automatically close during periods of non-use
- **Simple**: Exceptions
  - *Where restricted by health and life safety codes*
  - *Where serving areas designed for continuous operation*
  - *Systems with readily accessible manual dampers*

VAV Fan Control (Complex)

- Individual fans with motors ≥25hp
  - *Driven by a mechanical or electrical variable speed drive*
  - *Be a vane-axial fan with variable pitch blades OR*
  - *Have controls or devices to result in fan motor demand ≤50% of their design wattage at 50% of design airflow when static pressure set point = 1/3 of the total design static pressure*



Section 803.3.3.6

Heat Rejection Equipment (Complex)

New 2004 Requirement

- *Each fan powered by a motor ≥7.5 hp to*
  - have capability to operate that fan at 2/3 of full speed or less
  - Have controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device
- *Exception*
  - Factory-installed heat rejection devices within HVAC equipment tested and rated in accordance with Tables 803.3.2(1) through 803.3.2(3)

Section 803.3.3.8

Requirements for Multiple Zone Systems (Complex)

- Systems shall be VAV systems that are designed and capable of being controlled to reduce primary air supply to each zone to a minimum before reheating, recooling or mixing takes place
- Several exceptions

Duct and Plenum Insulation (Simple and Complex)

- Required for supply and return ducts and plenums
  - *Located in unconditioned space - R5*
  - *Located outside the building envelope - R8*
- Exceptions
  - *Located within equipment*
  - *Design temperature difference between interior and exterior of duct or plenum > 15°F*
- Ducts designed to operate at static pressures > 3 in. wg to be leak tested in accordance with SMACNA
- Complex: Furnish documentation that representative sections totaling at least 25% of the duct area have been tested and meet the requirements

Section 803.2.8/803.3.6

Duct Sealing
(Simple and Complex)

- Seal and securely fasten all joints, longitudinal and transverse seams and connections with:
  - *welds*
  - *gaskets*
  - *mastics*
  - *mastic-plus-embedded fabric systems*
  - *Tapes*
- Duct tape is not permitted as a sealant on any metal ducts

Pipe Insulation
(Simple and Complex)

- Thermally insulated according to Section 803.3.7 (complex system requirements refer to Table 803.3.7)

TABLE 803.3.7
MINIMUM PIPE INSULATION[a]
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER	
	≤1.5″	> 1.5″
Steam	1.5	3.0
Hot water	1.0	2.0
Chilled water, brine or refrigerant	1.0	1.5

For SI: 1 inch = 25.4 mm, Btu per inch/h · ft^2 · °F = W per 25 mm/K · m^2.

a. Based on insulation having a conductivity not exceeding 0.27 Btu per inch/h · ft^2 · °F.

Pipe Insulation Exceptions

- Exceptions
  - *Factory-installed piping within equipment*
  - *Piping conveying fluids between 55°F and 105°F*
  - *Piping conveying fluids not heated or cooled through the use of fossil fuels or electric power*
  - *Runout piping not exceeding 4 ft in length and 1 in. in diameter between the control valve and HVAC coil*

HVAC System Completion (Complex)

- Before issuance of certificate of occupancy
  - *Air system balancing*
  - *Hydronic system balancing*
  - *Manuals*

System Balancing
(Complex)

- Supply Air Outlets and Zone Terminal Devices
  - *Must Have Means to Air Balance*
  - *Discharge Dampers Prohibited on Constant Volume and Variable Volume Fans with Motors > 25 Hp*
- Hydronic Systems
  - *Individual Hydronic Heating and Cooling Coils to be Equipped with Means for Balancing and Pressure Test Connections*

Section 803.3.8.1

Manuals
(Complex)

- O & M Manual Required
  - *Contents*
    - Equipment Capacity and Required Maintenance
    - Equipment O & M Manuals
    - HVAC System Control Maintenance and Calibration Information
    - Written Narrative of Each System Operation

Heat Recovery for SWH

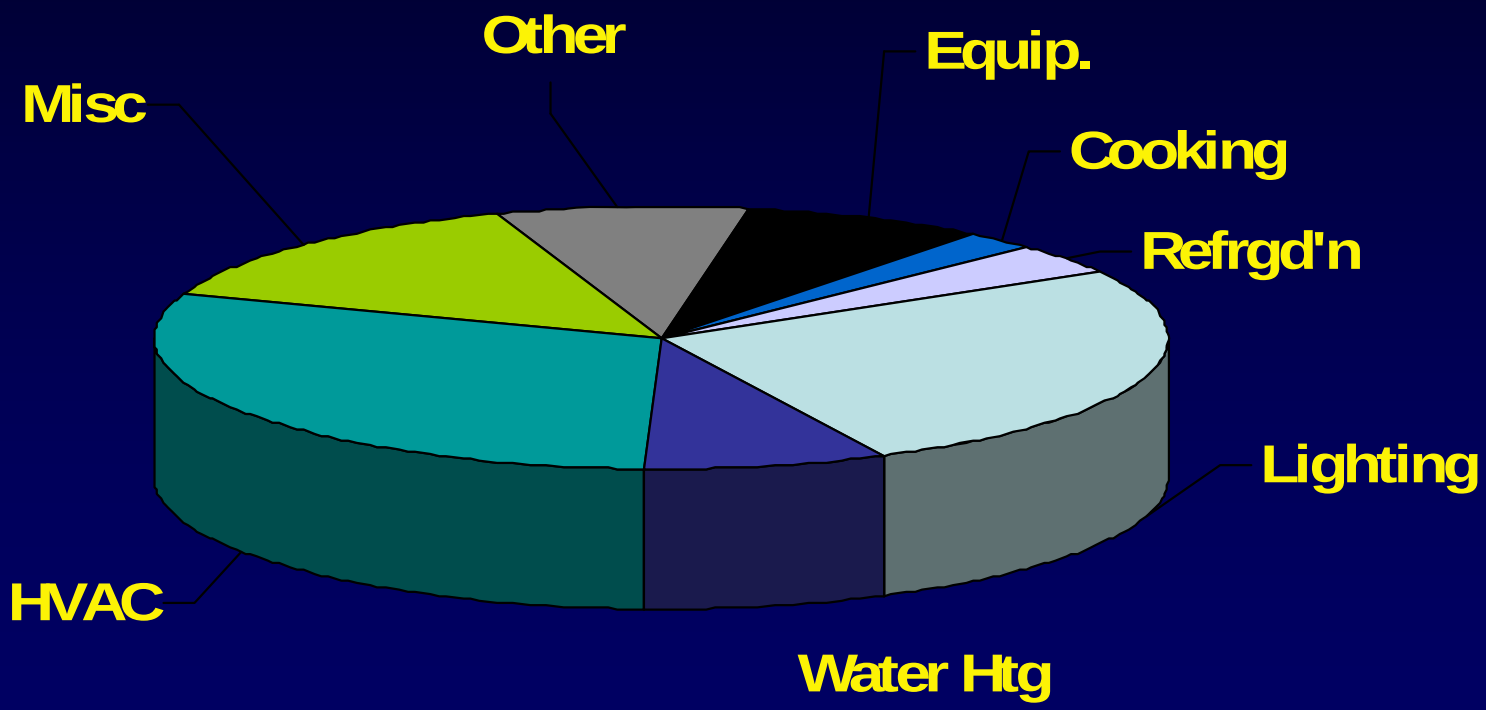
- *Condenser heat recovery required for heating/reheating of SWH provided:*
  - Facility operates 24 hours/day
  - Total installed heat capacity of water-cooled systems >6,000,000 Btu/hr of heat rejection
  - Design SWH load >1,000,000 Btu/h
- *The required heat recovery system shall have the capacity to provide the smaller of :*
  - 60% of the peak heat rejection load at design conditions or
  - the preheating required to raise the peak service hot water draw to 85 degree F

Section 803.3.9

Service Water Heating

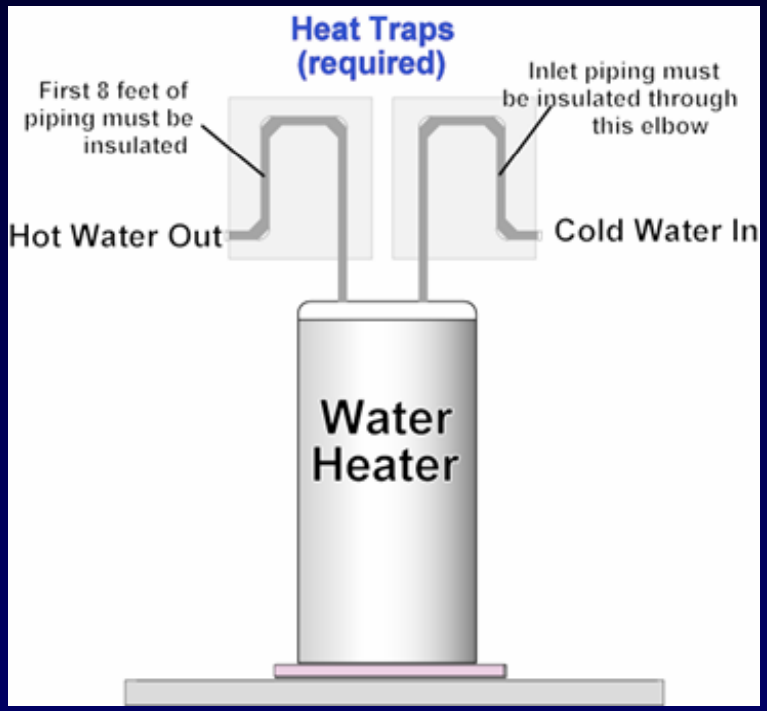
- Summary of requirements
  - *Heat traps to reduce standby losses*
  - *Pipe insulation to reduce distribution and standby losses*
  - *Circulation loop temperature controls to reduce distribution losses*

Typical Commercial Building Energy Consumption Patterns



Heat Traps

- Required on noncirculating hot water systems



Section 804.4

Pipe Insulation

- Noncirculating system insulation requirements
  - *First eight feet of outlet piping on systems with no integral heat traps*
  - *1/2 inch of insulation required*
- Circulating systems
  - *1 inch of insulation*

Section 804.5

Hot Water System Controls

- Application: circulating hot water systems
  - *Automatic time switches required to turn off the pump and heat tracer tape when it is not in use*

Section 804.6

More Information

- For additional training materials see

www.energycodes.gov/training/presentations.stm

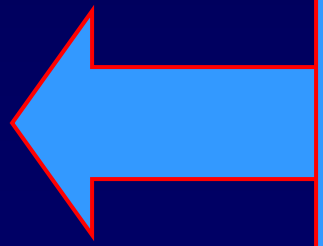
- Code Books:

www.iccsafe.org

Commercial Energy Code Compliance
Lighting Requirements
Chapter 8 NCECC

Outline

- Overview of Commercial Energy Codes
- Code Requirements
  - *Building Envelope*
    - Mandatory Requirements
    - Prescriptive Requirements
  - *Mechanical Systems*
    - Simple Systems
    - Complex Systems
  - *Service Water Heating*
  - *Lighting Systems*

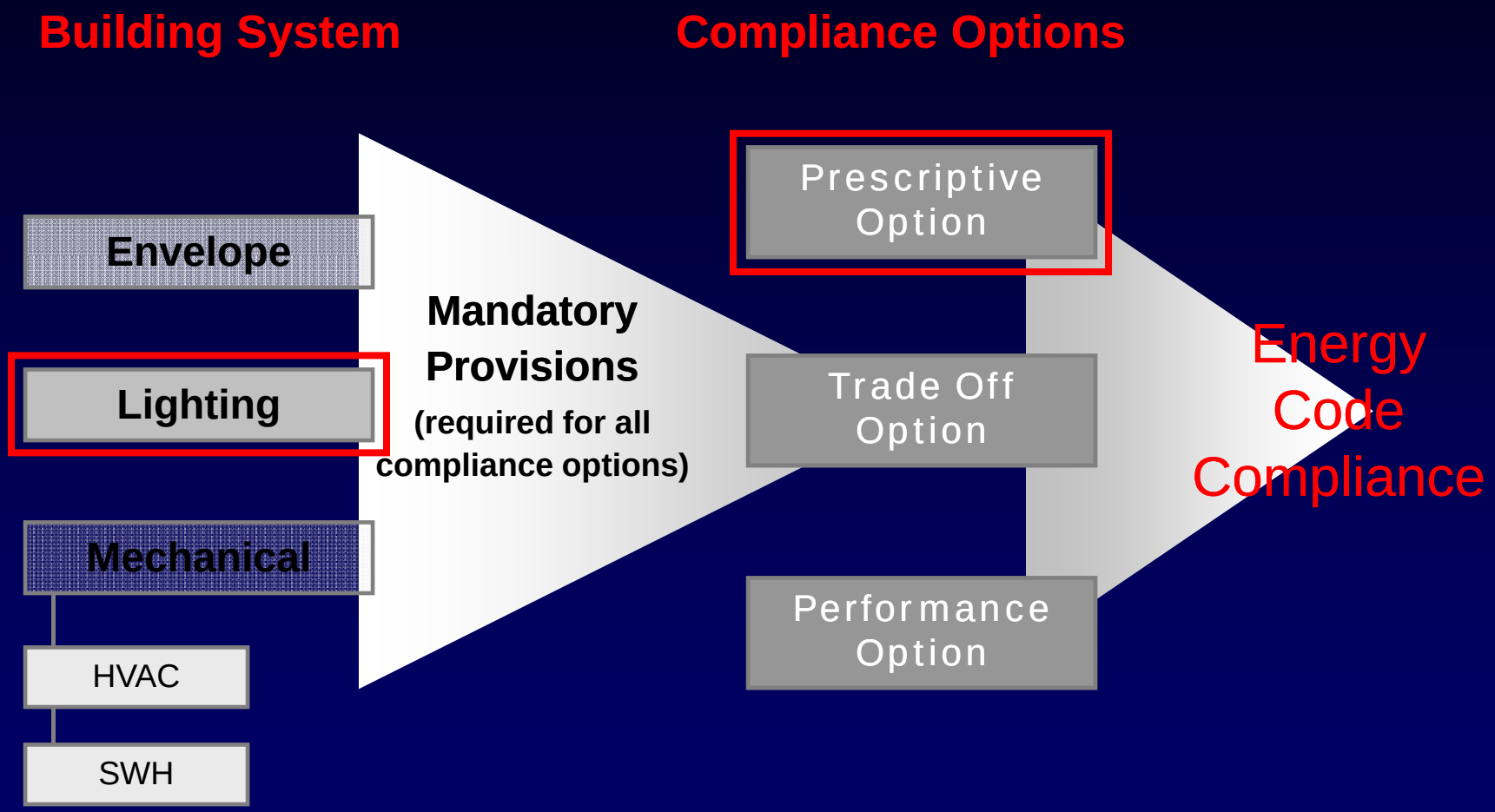


Requirements for Chapter 7 (ASHRAE 90.1) are covered in a separate presentation

IECC Chapters 7 and 8

Commercial Building Compliance Options	Scope	Building Envelope	Building Mechanical Systems	Service Water Heating Systems	Building Lighting Systems	Total Building Performance
Chapter 7 ASHRAE 90.1 Energy Standards for Buildings Except Low-Rise Residential Buildings	**Section 2**	**Section 5**	**Section 6** **(Simple Approach If Bldg < 25,000 s.f.)**	**Section 7**	**Section 9**	**Section 10**
Chapter 8 Design by Acceptable Practice for Commercial Buildings	**Section 801**	**Section 802** **(less than 50% glazing only)**	**Section 803**	**Section 804**	**Section 805**	**Section 806**

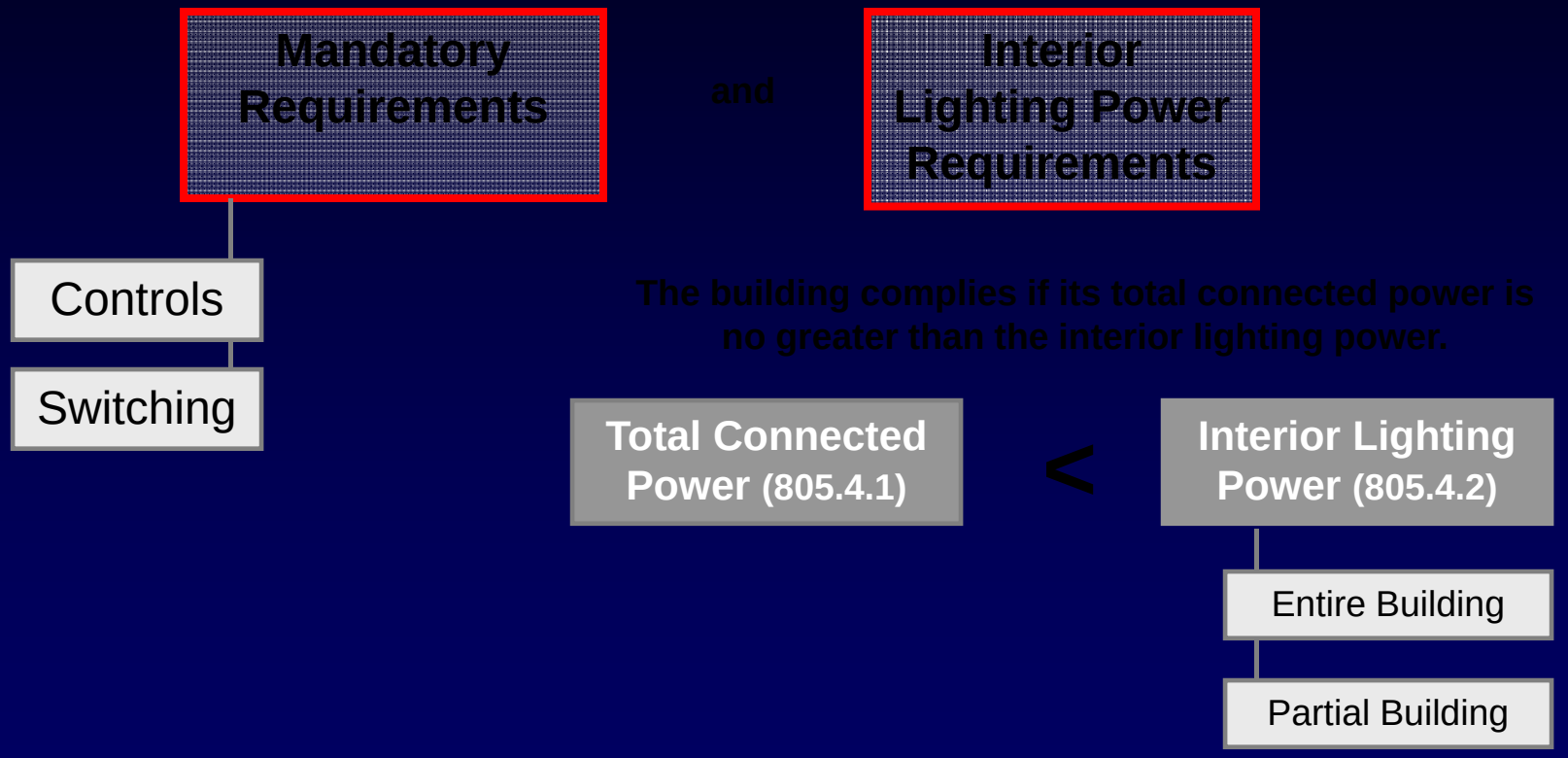
IECC Chapter 8
Design by Acceptable Practice



Scope

- 805.1 General
  - *Lighting system controls*
  - *Connection of ballasts*
  - *Max. interior lighting power*
  - *Min. acceptable exterior lighting equipment*

Interior Lighting Compliance



Interior Lighting Controls

- Lighting controls required for each area enclosed by ceiling height partitions
- Switch locations
  - *In view of lights*
  - *“On” or “off” indication from remote location*
  - *Occupancy sensor*

Section 805.2.1

Interior Lighting Controls

- Exceptions
  - *Emergency/security lighting*
  - *Stairway or corridor lighting for egress*

Section 805.2.1

Additional Controls

- Each area with mandatory controls must have:
  - *Light reduction controls (805.2.2.1)*
  - *Automatic lighting shutoff (805.2.2.2)*
  - *Guestrooms (805.2.2.3)*
- Exceptions
  - *only 1 luminaire*
  - *an occupant-sensing device*
  - *corridors, storerooms, restrooms, or public lobbies*

Section 805.2.2

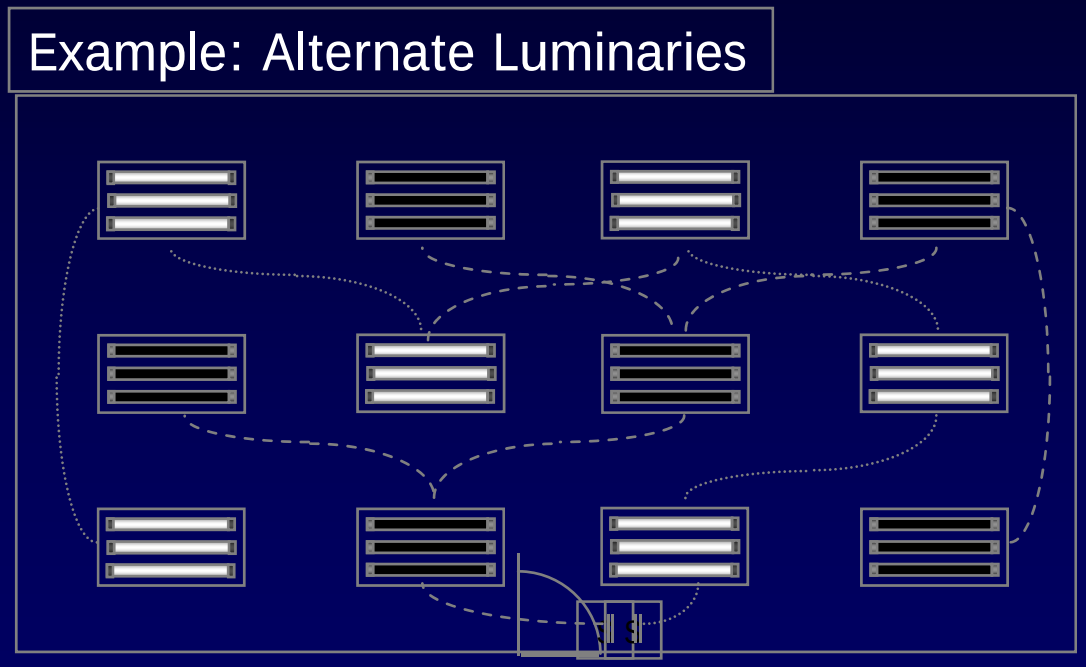
Bi-Level Switching
Light Reduction Controls

- Areas that are required to have manual control shall also
  - *Reduce connected lighting load uniformly by 50% for each space*
  - *Exceptions*

Section 805.2.2.1

Bi-Level Switching

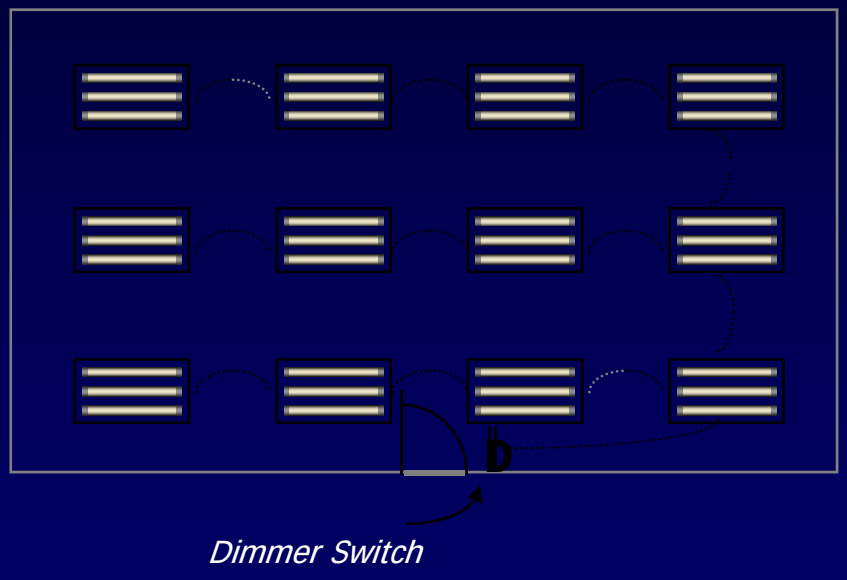
- Compliance Examples



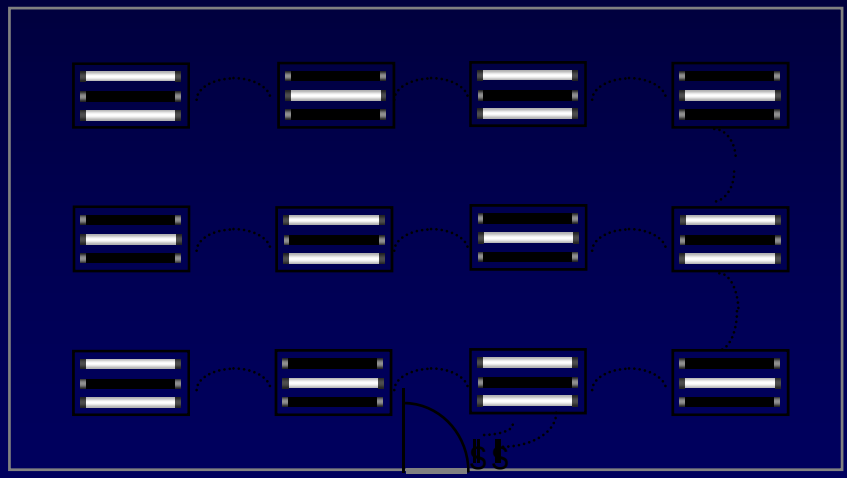
Bi-Level Switching

- Compliance Examples

Example: Dimmer Control Option



Example: Alternate Lamps (a/b)



Automatic Lighting Shutoff

- In buildings > 5000 ft^2
  - *must have automatic control devices to function either on*
    - Scheduled basis using time-of-day
    - Unscheduled basis by occupant intervention
- *In 2004 IECC requirement for spaces >250 ft^2 in buildings larger than 5,000 ft^2*

Section 805.2.2.2

Occupant Override

- Where automatic time switch control devices are installed to comply with Automatic Lighting Shutoff, device shall be equipped with an override switching device that:
  - *Readily accessbile*
  - *Located so that person using the device can see the lights or area controlled by the switch*
  - *Manually operated*
  - *Allows lighting to remain on for no more than 2 hours when an override is initiated*
  - *Controls an area <5,000 square feet*
- Some Exceptions

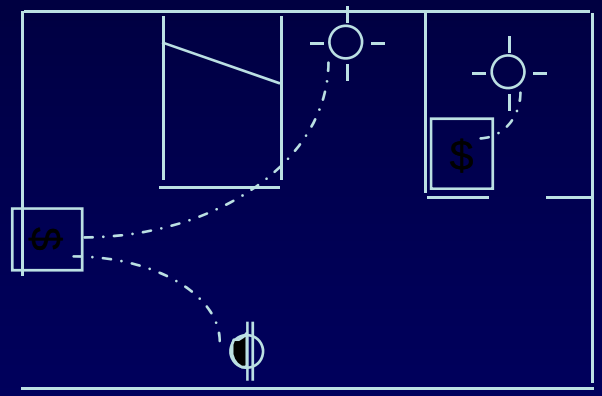
Section 805.2.2.2.1

Holiday scheduling

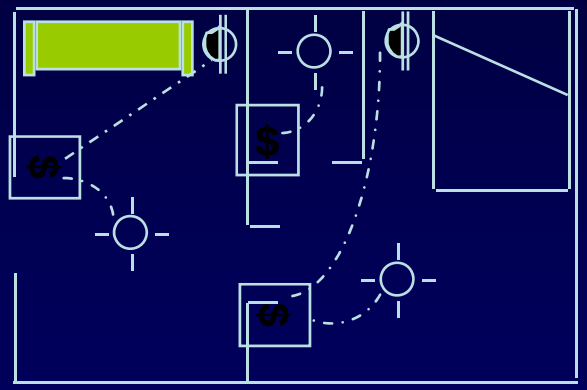
- If automatic time switch is installed:
  - *Automatic holiday scheduling feature that turns off all loads for at least 24 hours and then resumes to normally scheduled operation*
- Exceptions
  - *Retail stores and associated malls, restaurants, grocery stores, churches and theaters*

Guest Rooms

- Master switch required at entry



Standard Room



Suite

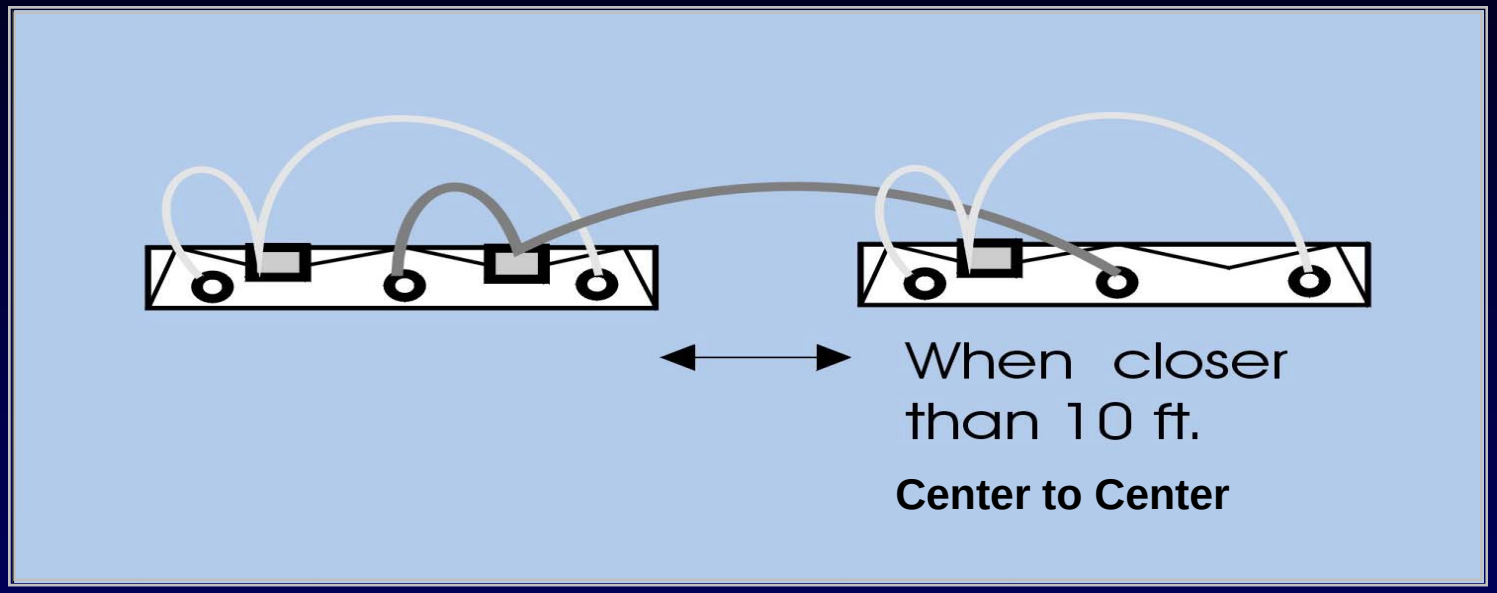
Section 805.2.2.2

Exterior Lighting Controls

- Automatic switching or photocell controls shall be provided for all exterior lighting not intended for 24 hour operation.

- Automatic time switches shall have a combination
  - *Seven-day and seasonal daylight program schedule adjustment*
  - *A minimum 4-hour power backup*

Tandem Wiring



- Exceptions
  - *Luminaires with electronic high-frequency ballasts*
  - *Luminaires not on same switch controls or not in the same area*

Exit Signs

- Internally illuminated exit signs shall not exceed 5 Watts per side

Section 805.4

Interior Lighting Power Requirements

Mandatory Requirements

- Controls
- Switching

and

Interior Lighting Power Requirements

The building complies if its total connected power is no greater than the interior lighting power.

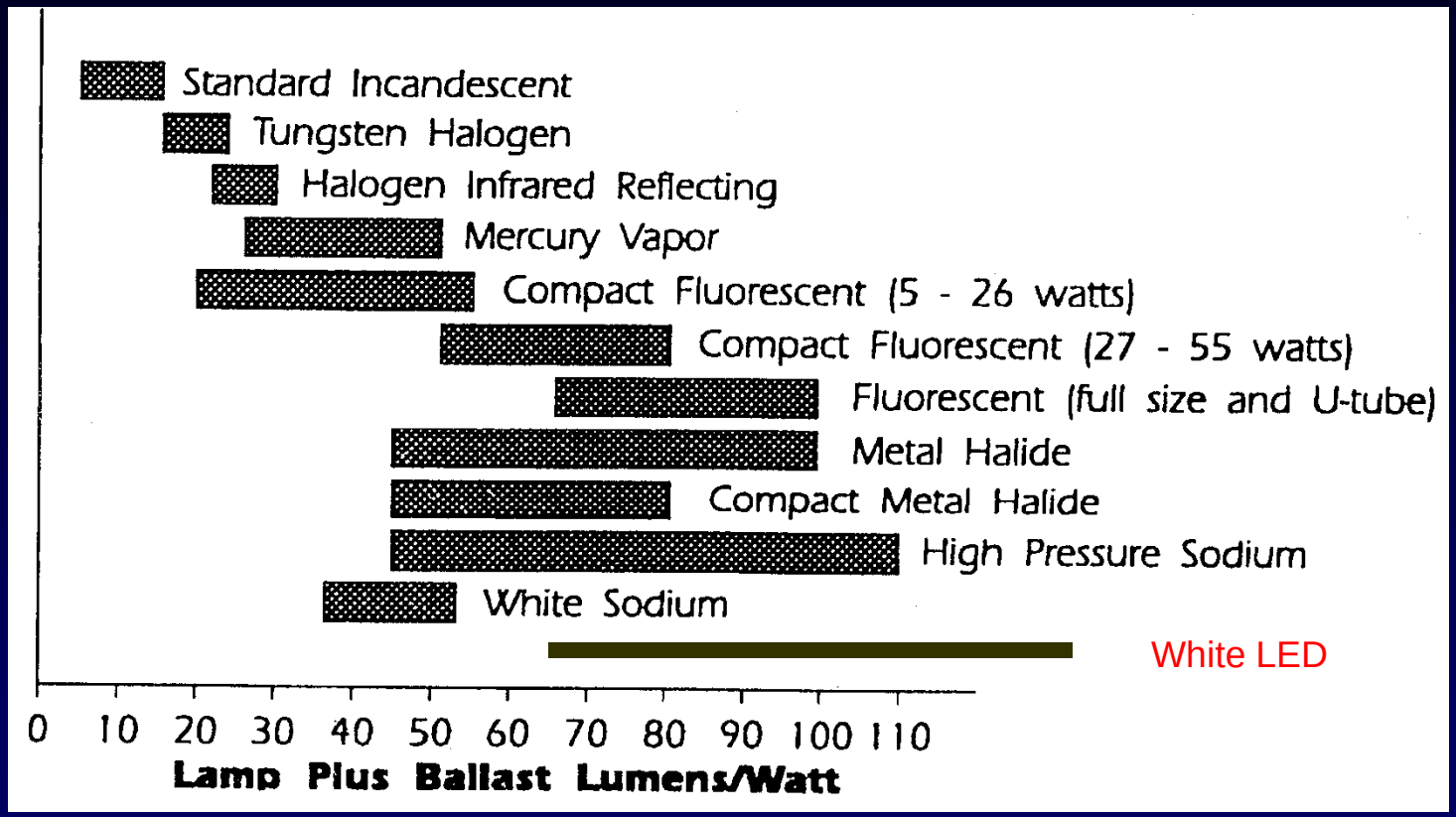
Total Connected Power **<** **Interior Lighting Power**

- Entire Building
- Partial Building

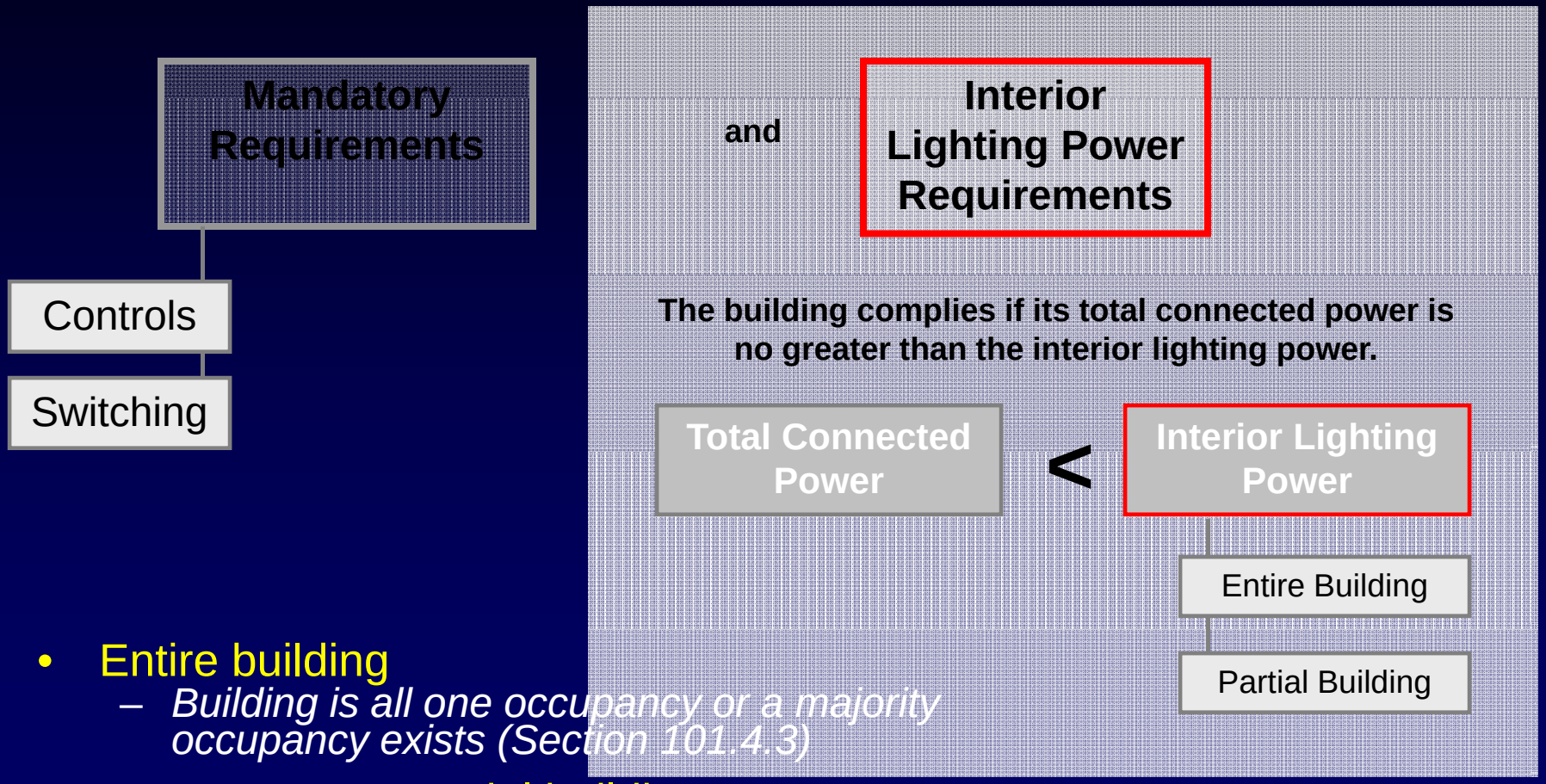
Total Connected Power

- Total connected lighting wattage includes:
  - *Lamp wattage*
  - *Ballast wattage*
- Sources of bulb/ballast wattages
  - *Manufacturer's literature*
  - *Industry default tables*
- Exceptions
  - *Specialized medical, dental, and research lighting*
  - *Professional sports arena playing field lighting*
  - *Display lighting for gallery exhibits, museums, and monuments*
  - *Guest room lighting in hotels, motels, boarding houses, or similar buildings*
  - *Emergency lighting automatically off during normal building operation*

Energy-Efficient Lighting Sources



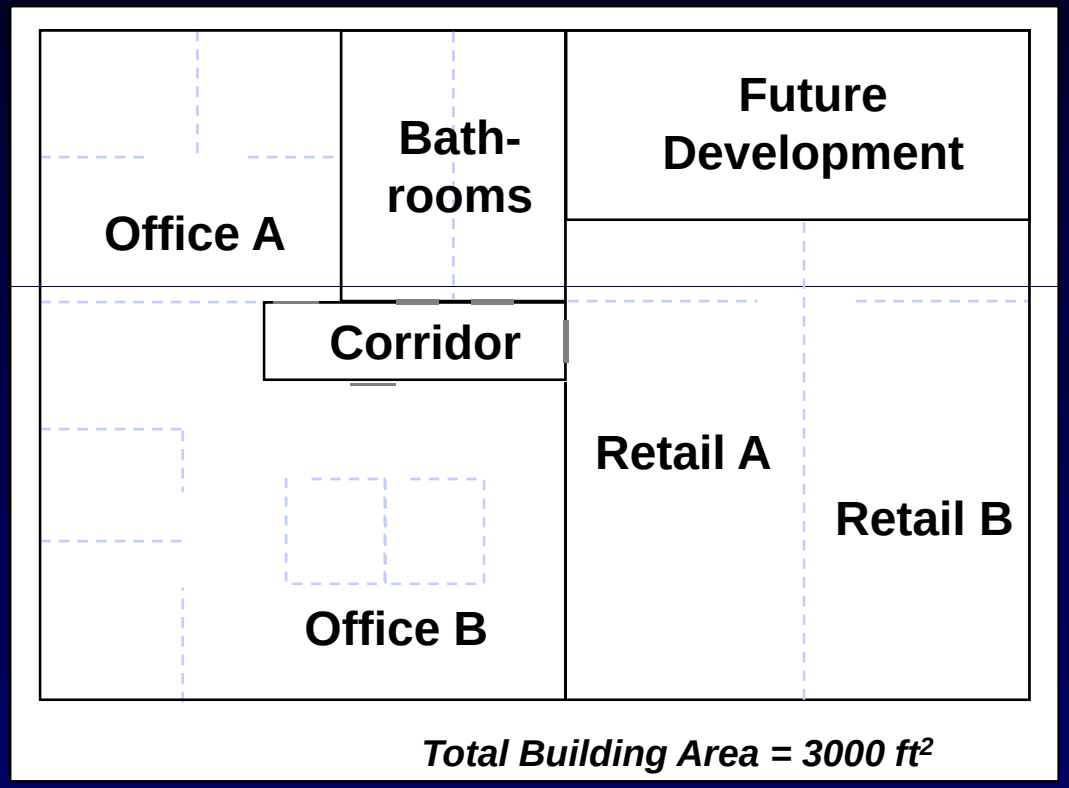
Interior Lighting Power



- Entire building
  - *Building is all one occupancy or a majority occupancy exists (Section 101.4.3)*
- Tenant area or partial building
  - *Use for tenant spaces in larger building or divide whole building into area types*
- **Table 805.4.2/Table 805.5.2**

What is the Interior Lighting Power Budget for this Building?

Office A:	400 ft^2
Office B:	850 ft^2
Bathrooms:	350 ft^2
Corridor:	50 ft^2
Retail A:	500 ft^2
Retail B:	500 ft^2
Future:	350 ft^2



Does the Building Comply?

- Determine the total connected power in watts for the proposed lighting
- Determine the interior lighting power budget for the entire building or space
- Building complies if:
  - *Interior lighting power budget - total connected power = 0*

Exterior Lighting

- Criteria
  - *Lighting power supplied through building electrical service*
  - *Must use energy-efficient lighting sources to highlight paths, walkways and parking areas*
    - ≥ 45 Lumens/Watt
    - Fluorescent
    - Compact Fluorescent
    - Metal Halide
    - High Pressure Sodium
- Exceptions
  - *Where approved because of the following considerations:*
    - Historical
    - Safety
    - Signage

Electrical Energy Consumption

- In buildings having individual dwelling units, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units

Section 805.7

Conclusion?

- We can't do it all in a day
  - *Web resources*
  - *Future workshops*
  - *Plan review training*
  - *Worked examples*
- But we have to start somewhere!
  - *Simple prescriptive techniques will be most common*
  - *Performance techniques usually involve professionals with a license on the line*
    - AIA, PE, etc.

Energy Consumption in Commercial Buildings Matters!

- More than half of energy use is for HVAC and lighting
- Typical energy bill equals 25% of total operating costs
- Climate sensitive design and off-the-shelf technologies can cut energy bill by 50%

Additional Resources

- www.thesciencebehind.com
- www.energycodes.gov/training/presentations.stm
- http://www.energycodes.gov/training/pdfs/iecc_com_wb.pdf

Section 9.4.1.2

Occupancy Sensors

- For high usage areas with irregular schedules
- Applications
  - *Private offices*
  - *Classrooms*
  - *Conference rooms*
  - *Break rooms*
  - *Restrooms*

Section 9

Mandatory Provisions
Exit Signs (section 9.4.3)

New Exit Sign Requirements

Internally illuminated exit signs shall not exceed 5 watts per face. 90.1-2004, IECC 2003